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RESEARCH ARTICLE

REVISED European small-town Renewable Energy Communities: Participatory design of supporting tools as a vehicle to engage and understand local communities and their energy related concerns

[version 2; peer review: 3 approved with reservations, 1 not approved]

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Abstract

Renewable Energy Communities (REC) are an emerging initiative that aims to contribute to the energy transition towards a more decentralised system in Europe by encouraging local communities to come together and invest in and operate renewable energy assets together. Decision-making processes of these communities need to be supported by adequate tools, which also can be used in the formation of the community groups in the first place.

In this paper a case-study of four European small-town communities in Berchidda (Italy), Ollersdorf (Austria), Ispaster (Spain), and Kökar (Finland) carried out in the context of the LocalRES project is presented, where a participatory design methodology has been applied to co-create community supporting tools. Feedback gathered during four citizen workshops is presented, showing that to optimally support RECs in their formation and operation three main topics need to be supported: (1) the technical realisation and potential upgrades of the energy system, i.e., visualising energy generation and consumption on an individual and a community level, (2) the financial and economic implications of investments, i.e., calculating costs and return on investment for the individual and for the community, as well

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Any reports and responses or comments on the

as (3) the social dimension and communication between community members and other relevant stakeholders, i.e., helping with community building and community engagement.

The participatory process presented in the case studies does not only serve to gather requirements for tool design, but it also is a useful vehicle to bring together all interested citizens and stakeholders to understand their needs and concerns. A summary of this detailed citizen feedback is also presented.

Plain language summary
To tackle the challenges of climate change we will need to rely a lot more on renewable energy sources. This is not only a technical problem, at the end of the day solar panels and wind energy are already widely available but also requires all of us to change our way of life and how we build our houses and consume our energy. REC are a new idea how to make it easier for all of us to get involved and contribute to the solution. The key idea is to engage with our neighbours and to jointly find ways to improve our local energy infrastructure by investing together into new local renewable energy sources.

In this paper we are describing how four small-town communities across Europe in Italy, Spain, Austria, and Finland are involved in a project that tries to help them build such a REC. We organised open workshops in each of these locations to gather feedback from local people in those communities on their energy goals and the information they need to decide what to do to achieve these goals.

Local knowledge collected in the workshops will directly influence the tools developed to support the creation and running of RECs across Europe. The main feedback we received has been that such tools should include information about technical and financial cost and benefits but also include social and community building features.

Keywords
Renewable Energy Community, Participatory Design, Co-Creation, Citizen Engagement, Energy Planning Tool

article can be found at the end of the article.



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REVISED **Amendments from Version 1**

The revised version of this paper incorporates all reviewer-requested changes and places stronger emphasis on the research gap, the study's objectives, and the corresponding outcomes. The Introduction was expanded and restructured, incorporating more state-of-the-art references. The introduction to the Methods section was removed, and more details about the chosen methodology were added. All previously included statistical data has been removed to focus exclusively on the qualitative results.

Additional tables have been included to present the age and gender distribution across the different workshops. An appendix has also been added to provide an overview of the community goals for each pilot site, the scenarios discussed during the workshops, and the benefits of using a planning tool in each case. To further highlight the study's contributions, a table with recommendations for the co-design of REC support and planning tools is now included. Each individual reviewer comment has been addressed and incorporated into this updated version of the paper.

Any further responses from the reviewers can be found at the end of the article

Introduction

The Clean Energy Package[1] recently released by the EU aims at a more efficient decarbonisation and a better integration of renewable sources into the energy system. The current energy system is undergoing a change from conventional fossil fuel use towards approaches based on renewable energies and is shifting from a centralised model towards more decentralised concepts. Within this transition REC are a new focal point aiming to actively involve consumers and citizens from the start of the design phase all the way to the end of the process, where a community is influencing the development of relevant energy products and services, such as for example the management of small power producers of renewable energy.

According to the EU Renewables Directive Article 2(16) a REC has been defined as "a legal entity: (a) which, in accordance with the applicable national law, is based on open and voluntary participation, is autonomous, and is 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; (b) the shareholders or members of which are natural persons, SMEs, or local authorities, including municipalities; (c) the primary purpose of which is to provide environmental, economic, or social community benefits for its shareholders or members or for the local areas where it operates, rather than financial profits"[2].

Compared to other market players, RECs are therefore mainly non-commercial actors in the energy ecosystem empowered to produce, consume, store, sell and share renewable energy in a local self-controlled setting. The REC is a type of entity and will be based on adequate legal frameworks, which need to be created in the context of national renewable energy policies by member states. The purpose of these energy communities is to be empowered to participate and get access to the local energy markets, ensuring that no discrimination through regulatory and administrative barriers hinder the access and engagement of the REC. A value driven approach is envisioned for the RECs based on non-commercial purposes such as social, environmental, or economic community benefits[3,4].

However, the establishment of RECs faces a combination of technical, financial, social, and regulatory barriers that can hinder their development and long-term viability. One of the main obstacles lies in the complex regulatory and administrative frameworks that vary across regions and often lack clarity regarding community participation and grid integration[3,4]. Additionally, financial barriers, such as high upfront investment costs, limited access to financing, and uncertain revenue streams, often discourage community initiatives[5]. Social and organizational challenges, including insufficient public awareness, lack of trust among stakeholders, energy injustice, non-willingness to engage, and limited technical expertise, are further aspects to consider when trying to build a RECs[6–8].

Municipalities play a pivotal role in overcoming these barriers by acting as facilitators, enablers, and sometimes active partners in REC development. As local governments, they are well positioned to mobilize stakeholders, provide legitimacy, and align energy initiatives with broader sustainability goals[9,10]. Municipalities can contribute by offering access to public assets such as rooftops or land, integrating RECs into local energy and land-use planning, and supporting awareness campaigns that foster citizen engagement. Moreover, their involvement in co-investment or public-private partnerships can help reduce perceived risks and attract additional funding. In this way, municipalities act as intermediaries between top-down energy policy and bottom-up community action, ensuring that RECs are embedded within a coherent local energy transition strategy.

This work is part of the Horizon Europe LocalRES project[11]. LocalRES stands for **"**Empowering Local Renewable Energy Communities for the Decarbonisation of the Energy Systems" and seeks to deploy innovative local energy systems led by RECs, in order to enable a socially fair energy transition. It intends to hand control of renewable energy production and management back to communities and citizens by developing digital tools and optimizing energy vectors such as electricity, heating and mobility.

While a lot of focus of designing novel renewable energy solutions is on technical innovation and development[12], social innovation is of equal importance to foster acceptance and drive sustainable change. It has been recognised that the involvement of citizens as part of the energy transition to enhance the decarbonisation of the local energy system needs to consider particularities of participants, their social norms, and other cultural aspects to improve the motivation and commitment to increase participation in the RECs.

One approach to achieve these aims is to create and co-design tools[13], which can support the REC to reach community goals set in the energy domain. Such tools should assist the decision-making process, showing if community energy projects are suitable and providing the required information on how to generate, store, consume and sell the energy. To achieve maximum acceptance and support of the community, such tools have to be co-designed with the citizens to collect and finally deliver all necessary technical, economic, environmental, and social information. This trend is evident in numerous Horizon Europe projects-not only in the *LocalRES* project presented here, but also in initiatives such as *ENPOWER*[14], *HESTIA*[15], and *E2District*[16]. However, despite the European Commission's recent shift toward a more holistic approach to energy research that emphasizes social and community dimensions, much of the academic literature continues to focus predominantly on the technical aspects, often overlooking the crucial social component[17–19]. Tools which are meant to support energy community activities also need to present the benefits and drawbacks of relevant scenarios in an uncomplicated language to ensure that the general public being the users of these tools can understand the information provided. Such easily understood information reduces the perceived complexity and should empower citizens to make informed decisions about community goals and scenarios regarding the local energy system. The change from a centralised to a more decentralised energy system while putting the RECs in the centre[20] requires the engagement of local communities of different sizes, different socio-economic backgrounds, and different regional circumstances. This work presents a co-design activity from four distinct demonstration sites across Europe representing small communities in different climate zones with different requirements and preferences as follows (see Figure 1):

- **Berchidda (Italy)** is a town in the north of the island of Sardinia with around 2,800 inhabitants. The community is characterized by a strong local identity and an economy traditionally based on agriculture, small-scale industry, and tourism. Berchidda experiences a Mediterranean climate, with hot, dry summers and mild, wet winters, which shapes local energy needs, particularly for cooling in summer and heating in winter. In recent years, the town has shown growing interest in sustainable development initiatives, including renewable energy and energy efficiency projects.
- **Ollersdorf (Austria)** is a small town of approximately 1,000 inhabitants located in the Burgenland region of eastern Austria. The area experiences a temperate continental climate, characterized by warm summers, cold winters, and moderate precipitation throughout the year. These climatic conditions influence local energy demand, particularly for heating during the winter months. The municipality has a strong tradition of community cooperation and has been active in implementing local sustainability initiatives. Ollersdorf is a very advanced community with very active and engaged members where many RE projects are already put into place.



Figure 1. Demonstration sites of the LocalRES project.

- **Ispaster (Spain)** is a small municipality with approximately 740 inhabitants, located in the Basque Country in northern Spain. The town experiences an oceanic climate, characterized by mild temperatures, high humidity, and abundant rainfall throughout the year, which supports its lush green landscapes and agricultural activities. The community is known for its strong local identity, However, Ispaster is a relatively young REC, where a significant degree of scepticism among residents was observed.

- **Kökar (Finland)** is a small municipality with approximately 230 inhabitants, located on the Åland Islands in the Baltic Sea. The area experiences a cold temperate climate with long, snowy winters and mild summers, which significantly influences local energy needs and consumption patterns. Despite its small population, Kökar has a close-knit community and a strong tradition of local governance, with a high interest particularly in the other REC of the LocalRES project.

Although all four towns are relatively remote, the varying levels of REC development revealed notable differences in residents' awareness and understanding of the energy transition, as well as the perceived importance of local energy projects and activities. In more advanced communities, such as Ollersdorf, high engagement and prior experience with renewable energy initiatives facilitated constructive discussions and active participation in co-creation workshops. Conversely, in newer or less established RECs, like Ispaster, scepticism and limited familiarity with energy transition concepts required additional effort to build trust, explain technical and economic aspects, and encourage meaningful participation. That demonstrated the need to tailor communication, support tools, and participation approaches to the unique context and readiness of each community.

Therefore, a significant research gap exists in understanding how participatory and co-creative approaches can inform the design of inclusive, socially responsive, and technically robust tools that not only support the operation of RECs but also strengthen trust, transparency, and collective decision-making at the local level.

The objective of this study is to examine how co-creation methodologies can be effectively employed to engage citizens and local stakeholders in the development of RECs. By focusing on the intersection of technical, economic, and social dimensions, the research seeks to understand how participatory processes contribute to the design of tools and frameworks that support community-based energy initiatives. Ultimately, the study aims to generate insights and recommendations that foster inclusive citizen participation, enhance trust and transparency in decision-making, and promote the successful establishment and long-term sustainability of RECs in small-town European contexts.

In the following article, we present an approach for engaging local communities to gather relevant input to facilitate the co-design of supporting or planning tools that account for local structures and specific requirements. The outcomes discussed stem from the *LocalRES* project[20] and provide insights that will inform the design process for developing community-planning tools aimed at fostering the establishment and effective operation of RECs.

Methods

The chosen approach was a participatory or co-design method, which involved all relevant stakeholders, such as organisations, communities, and individuals, in the design process to ensure that local knowledge, cultural context, and community needs shape the final outcomes[13,21]. These collaborative approaches enhance ownership, acceptance, and long-term use of community tools[22,23] but can face challenges like participation or gender gaps when certain groups are excluded[24,25].

Four co-design citizen workshops were conducted at the demo sites of the LocalRES project in Berchidda, Ollersdorf, Ispaster, and Kökar (see Figure 1). A preparatory representative workshop for each site served as an initial baseline for developing specific community goals and scenarios, based on existing energy assets and connections as well as potential future assets, upgrades, or alterations, which could potentially contribute to the community's renewable energy goals. Each of the four representative workshops was attended by a citizen representative who showed high interest in the topic and project and acted as a local champion or ambassador together with local energy experts, the mayors who were driving this initiative and the project researchers. They took place in an online setting during March/April 2022 and lasted about 2 hours each. The corresponding four citizen workshops were then organised in a face-to-face setting in April/May 2022 at the demo sites themselves with a duration of about two and a half hours each. The participants were local citizens of the pilot sites who had an interest in RECs and the energy transition, including the local mayor as well as one to two local energy experts who already participated in the preparatory representative workshops and two project researchers. The citizen workshops were o rganised and delivered by project researchers in the respective local languages and documented using detailed paper-based minutes, which were translated into English for further analysis.

To engage directly with interested parties and collect their feedback for the benefit of the project was the primary objective of the citizen workshops. They started with presentations, re-capturing the purpose of the LocalRES project as well as presenting mock-ups for a potential planning tool with its functionalities, including the most relevant scenarios for each pilot site identified during the representative workshops (see Appendix). The planning tool aims to support both experts and citizens in developing and managing a REC. For experts, it provides a comprehensive vision of the energy system, helping them design and assess long-term scenarios while

evaluating the impact of decisions on emissions, costs, and sustainability, as well as supporting land-use planning. For citizens, it promotes active participation by granting access to relevant information, enabling them to make informed decisions as community members, understand how choices affect their personal situations, and perform individual simulations to measure their impacts (the newest version of the planning tool can be found here ENPOWER). It was mentioned that the mock-ups were only meant as an idea for what the planning tool could look like and that based on the outcomes of the workshops it will be adapted to the needs and requirements of each community. It was also emphasized how a planning tool can be beneficial for a REC to reach joint community goals. Furthermore, the purpose of a support tool was described, giving all involved participants some insight into the bigger picture, what should be achieved as a community goal and which opportunities according to different scenarios are available. The possibility to create new scenarios and discuss it with the community and how it could lead to a better exchange between community members was also discussed.

The outcomes of the representative workshops were used to create a questionnaire for each pilot site, including the individual goals and scenarios for each community (see Appendix). No additional pilot test of the questionnaire was conducted due to small, expected sample sizes. The main purpose was primarily to initiate a discussion amongst workshop participants and to gather mainly qualitative feedback from citizens. Therefore, the questionnaire was not intended as a rigorous quantitative evaluation source. There were some initial concerns that the questions provided might be too difficult for participants to understand, but that was one of the main intended goals to find out on which level each energy community currently was on. The questionnaire was meant as a starting point for discussion and to collect qualitative input. Participants of the workshops were encouraged to discuss the questions with people sitting next to them or at the same table. Therefore, questions were not pre-tested, as would be expected from a thorough empirical study, but rather developed according to the information requirements of the support tool design team. All workshops only took place once and thus no follow-up questionnaire was conducted.

The questionnaire[26] was paper-based and structured in the way, that the first questions were the same for all four test sites and only goals and scenarios differed according to the individual test sites. It was translated into the local languages (Italian, German, Spanish, Euskera, and Swedish) and handed out after the presentation so that participants got some time to complete it. Participation was voluntary and anonymous, and it was used to start the discussion about the understandability of the presented planning tool (the newest version of the planning tool can be found here ENPOWER), the goals, and scenarios as well as other goals and scenarios of interest and the community development in general (see Appendix). Detailed minutes of the sessions were recorded and used as qualitative feedback in addition to the written comments given on the questionnaire by participants. No audio or video recording took place for the citizen workshops, while the online representative workshops were recorded for internal use by the LocalRES project partners. The datasets presented in this study can be found in the Open Science Foundation repository[26].

In Berchidda, the table arrangement encouraged small-group discussions, while in Ispaster, participants sat in a half-circle and engaged in a collective discussion about the questions and scenarios. In Ollersdorf, participants were initially quiet and focused on completing the questionnaire individually, but once the scenarios relevant to their town were introduced, the discussion became lively and engaging. In Kökar, participants showed strong interest in the LocalRes project and in learning about the experiences of other communities, highlighting the importance of actively listening to participants and clarifying any misunderstood questions or information.

Participants and recruitment

All interested citizens of the four respective communities were invited to the workshops by the community representatives via locally appropriate communication channels. Most of the recruitment channels were the same for all pilot sites. Advertisement of the workshop via the official website or newsletter of the municipality or the official Facebook site were used by all pilot sites except Ispaster, which used a face-to-face approach, i.e., direct personal invitations by the local mayor, to get citizens interested and involved in the renewable energy community project. Others used additional locally relevant communication channels, such as by e-mail (Berchidda) or letters by post (Kökar).

A total of 64 citizens were engaged across the four demonstration sites. For Berchidda 13 people participated in the citizen workshop, in Ispaster 14 participants showed up, while Ollersdorf had 22 participants, and Kökar was able to engage 15 interested parties.

Ethical considerations

The LocalRES project has undergone ethical review by the European Commission (Proposal Number 957819) and obtained ethical approval for conducting the citizen workshops at the four pilot sites. Consent of participants to collect anonymous data in the context of the LocalRES project was sought orally at the beginning of each workshop by the organisers and participants were informed that they could withdraw from the study at any time. All workshop activities and questionnaires were completely voluntary, and all data collection was anonymous.

Data analytics procedure

The main focus of this work has been the qualitative analysis of the comments written down by participants and recorded in the workshop minutes. They were collated to be used to inform future developments on all aspects that are relevant to the citizens in the different communities.

There was one project researcher fluent in the respective local languages acting as coder for each pilot site, who translated the feedback into a prepared Excel sheet for evaluation.

Qualitative comments were systematically organised according to recurring topics by pilot site and then compared to each other.

Results

Characterisation of the citizen workshops

Ollersdorf has been the most advanced community amongst the four demo sites. There was a general good understanding of the energy community, which already was well established and interested to move to the next stage by integrating a community support tool to better communicate with each other and reach its community goals. The goals discussed during the workshop included achieving 100% renewable energy for the community, energy self-sufficiency and supply security (see Appendix). The workshop discussion was very focused and on a high level regarding the interests, needs and requirements when it came to possibilities implementing new energy systems in town. Broadening the scope of the planning tool to include topics like water usage or aspects around food was an extended interest voiced by workshop participants.

While the discussion in Ollersdorf was very focused, the discussion in Berchidda was lively with a different focus. The goals of the community discussed during the workshop included how to save on the cost of energy and maximise the return on investment, but also achieving energy self-sufficiency and enabling every individual within the community to freely choose what equipment to install without jeopardising grid operation. Participants in Berchidda showed strong concerns about costs and financial aspects, particularly regarding the current rise in energy prices. There was a general worry that energy investments would not bring the right return, and it was proposed to investigate local, national, or even EU-level incentives and grants to cover installation costs. Therefore, the discussion was concerned not just around sustainability questions but also how to make the energy community profitable. Despite the focus on financial issues another aspect that came up during the workshop was privacy concerns as a sensible topic.

Ispaster is a very young energy community and therefore their focus was mainly how to develop the community itself. Energy goals discussed during the workshop included the supply of all public buildings with 100% renewable energy, self-sufficiency of the local school, reduction of the dependency on the main grid and achieving energy autonomy, as well as promoting communal energy production in the town (see Appendix). Also, questions like how to engage more people and to broaden the scope of the community were reoccurring themes. A suggestion was to integrate more subjects of interests into the planning tool, for instance socioeconomic activities to support the development of local businesses in the industrial area were mentioned. Another point that came up was the suggestion to use local heroes or energy champions to represent the community as well as to approach and engage more citizens in energy activities.

Participants in Kökar showed a comprehensive interest in the other demo sites and the LocalRES project in general. Goals specific to Kökar addressed during the workshop included the overall increase of renewable asset utilisation, achieving self-sufficiency on the island, increasing the reliability of the electricity supply, and the development of EV charging infrastructure (see Appendix). Participants were very forthcoming to express their personal views and ideas. While in other pilot sites there seemed no major problem with the questionnaire, some participants in Kökar required extra explanation from the organisers to understand the questions and scenarios. The workshop revealed a knowledge gap between participants regarding energy topics, which led to the difficulty of some to express their wishes and needs in more technical terms. This outcome reflects very well, that each energy community and each individual in the community is at a different stage and that this needs to be assessed and the results need to be integrated into community planning tools. Another aspect of interest, similar to Ispaster, was the establishment of energy champions or ambassadors, who could mitigate the difficulties which arose during the workshop by communicating and translating complex energy topics between experts and the citizen.

A common observation amongst all pilot sites was a clear demographic shift towards older and male participants. Over 78% of participants were older than 45, and more than 30% of participants were older than 65 (Table 1).

Only 1/3 of the participants were women. The workshops demonstrated very clearly that mainly men participated and that women were underrepresented (Table 2).

This issue has already been noticed in other EU Horizon 2020 projects[27] as well and needs further investigation to ensure an equal representation of all relevant stakeholders.

Table 1. Age distribution.

	18–24	25–34	35–44	45–54	55–64	65+
Berchidda	0%	15%	15%	23%	8%	38%
Ollersdorf	0%	0%	9%	14%	36%	41%
Ispaster	7%	7%	21%	29%	29%	7%
Kökar	0%	20%	0%	13%	40%	27%

Table 2. Gender distribution.

	Female	Male
Berchidda	31%	69%
Ollersdorf	39%	61%
Ispaster	14%	86%
Kökar	38%	62%

Feedback of workshop participants

Coming back to the identified key research gap in the development of RECs concerning the limited understanding of how participatory and co-creative approaches can meaningfully shape tools that are both technically robust and socially responsive, tools that support trust, transparency, and collective decision-making at the local level. Addressing this gap, the study examined how co-creation methodologies can engage citizens and local stakeholders in designing frameworks that reflect local needs and concerns (the newest version of the planning tool can be found here ENPOWER).

The results presented below illustrate how our participatory engagement approach enabled the collection of locally grounded insights and requirements that inform the co-design of REC support and planning tools. These findings demonstrate how community input can be translated into practical design criteria, directly contributing to closing the identified research gap (key Recommendations for Co-Design of REC Supporting Tools can be found in Table 3).

The feedback of workshop participants with regards to potential support tools for REC can be structured into the following three categories:

- technical and presentation, i.e., tools for visualising energy generation and consumption on an individual and a community level,
- financial and economic, i.e., tools for calculating costs and return on investment for the individual and for the community,
- social and communication, i.e., tools that help with community building and community engagement.

While the three categories are interrelated and cannot easily be separated, it has been found that to create and maintain a viable REC information on all three is required by participating citizens. The general conclusion of the workshops was that the more relevant information is given the more participants feel empowered to make informed decisions and take actions.

Furthermore, the citizen workshops made very clear that community supporting tools need to be adapted both to the specific requirements of the participating town as well as to the needs of the individual end users. Across the board it has been observed that the presented tool mock-ups seem to be difficult to understand and overly technical for a distinct

Table 3. Key Recommendations for Co-Design of REC Support and Planning Tools.

Theme	Recommendation Summary	Implications for Tool Design
Localisation & Real Data	Tools must reflect local conditions and use accurate, community-specific data.	Base scenarios on real energy flows, infrastructure, and consumption patterns; avoid vague estimates.
User Diversity & Technical Literacy	Different users require different levels of detail and clarity.	Provide layered interfaces; design for both individual and group use.
Visualisation	Clear, intuitive visual representations are essential for comprehension.	Use simple dashboards, maps, diagrams, and transparent indicators of energy generation and consumption.
Financial Transparency	Users need clear cost–benefit and ROI information at both individual and community levels.	Integrate feasibility studies, grants, incentives, maintenance costs, and administrative steps.
Social & Communication Features	Community engagement and communication must be supported.	Include messaging, notifications, feedback channels, and features supporting collective decision-making.
Platform Flexibility	Communities vary in preferred communication and interface formats.	Provide mobile apps, web-based tools, and paper-based alternatives depending on local preferences.
Trust & Data Privacy	Transparency and data governance are crucial for adoption.	Make data handling practices explicit; co-design privacy rules with communities.
Cross-Community Learning	Communities want to learn from successful examples elsewhere.	Incorporate case studies, shared experiences, and benchmarking tools.
Holistic Community Integration	Citizens link REC development to broader local priorities.	Allow expansion into sustainability topics (e.g., mobility, food, waste, water, local economy).
Individual & Collective Decision-Making	Tools must support personal choices and community goals simultaneously.	Provide action guidelines, role descriptions, and visualisations showing individual contributions to shared goals.

subset of participants. Therefore, the development of community tools needs to consider the varying degree of technical literacy.

In the following we will detail the specific feedback received during the workshop sessions. A major point has been that community goals and scenarios must be sufficiently specific, elaborated and provide information on currently available as well as future renewable energy sources. This includes the energy efficiency of the current system as well as pathways towards upgrades and improvements that can be installed to meet the requirements of the energy network with respect to current and expected energy consumption and production. To that end, the importance of adaptability towards each community who are interested in using support tools to plan and organise their energy community activities has been pointed out. For the creation of individualized goals and scenarios it is essential that those goals and scenarios are based on real data. Vague information and estimations were perceived as insufficient and as a reason not to use or introduce support tools for the community. To get a better understanding of the energy load of the community and to be able to adjust personal behaviour accordingly, it was suggested to make the energy flows and energy balance of the town available as well as giving some information about the existing energy systems in town.

Not only the information provided itself, but also the preferred mode of presentation differs between communities. Different user interfaces and platforms have to be targeted by community supporting tools. The workshops revealed some differences between the four demonstration sites. For example, workshop participants in Berchidda were more interested in a mobile application in comparison to participants in Ollersdorf, as well as in comparison to Kökar. On the other hand, participants in Ollersdorf have been more interested in a web based platform compared to participants in Berchidda, as were participants in Ispaster. Not all participants felt comfortable with electronic means of communication, with some voicing a preference for paper-based information.

A reoccurring topic during the workshops was investment costs in relation to benefits and disadvantages expected from potential upgrades of the energy system. These have to be embedded in the real circumstances and based on real data relevant for the local community. Those requirements dominated the comments written down by participants accompanied by the wish to be presented with relevant data in a simple and easy to understand manner. Information on the real expected return-on-investment is required for each individual personally involved by investing in personal or communal assets. Cost of maintenance, repairs, transport, logistics and who is eligible to install systems have to be addressed as well.

Grants, incentives, and funding opportunities for individuals as well as for the community have to be part of the presentation. It was found to be not sufficient enough to focus on technical indicators only, but to also provide relevant information concerning administrative issues and how to apply for relevant financial support.

Two levels of interest were established during the workshops; one was concerning the community level and the other the individual level. For both not only a detailed breakdown on costs and benefits, but also clear instructions and guidelines how to get actively involved to contribute to community goals will be required. Feasibility studies on both levels have been another topic of interest, with a clear view that unrealistic goals and unapplicable scenarios should not be presented at all.

Finally, social and community engagement aspects must be addressed. Community support tools need to not just accommodate participation in the decision process but also communication between users of the tools should be enabled. A feeling of being heard and taken seriously and feeling actively engaged needs to be conveyed. Particularly the communication aspect was a reoccurring request by workshop participants in all pilot sites, looking for enhanced communication, better coordination and planning of actions, as well as giving each participant a voice to express thoughts, ideas, and networking opportunities.

While the interaction between energy systems and suppliers, public service and municipalities, and private citizens was mentioned as relevant and the reliance on real data was seen as crucial, data privacy issues were a concern, which needs to be focused on when constructing tools for the community. The process of designing any tools has to be as transparent as possible and a trustworthy relationship between citizens and any service providers has to be established before any action can be taken.

Amongst workshop participants there was a clear preference to use community planning tools not just individually, but in a community focused group setting as well. However, overall participants fall into either of two segments, those who prefer to use a tool for themselves and those who prefer a group setting. For any supporting tools this means that information and results can be used in different settings and circumstances.

There was a general interest to broaden the scope of the energy community by not just focusing on energy systems and improvements of the same only, but to include other relevant topics as well. Those topics are usually highly individualised and specific to the community, but included for example health, sustainability, cleaning, washing, composting, locally produced food, water supply, traffic, sewage, as well as alternative CO2 and energy reduction measures, fire and flood protection and the development of economic aspects such as businesses and employment strategies in the region. In conclusion this means that energy communities have to be thought in a broader context and that they are also a vehicle for citizens to engage with each other and with wider local and communal concerns.

Participants showed an interest in becoming role models, not just individually but also as an energy community. Such RECs could lead the way for other communities, and as a consequence future planning tools should reflect on the possibility to share information about successful community projects,

so that new communities can learn from the experience of more established existing communities in other parts of Europe.

Limitations

The main limitation of the presented case studies is a potential selection bias; only interested parties participated in the workshops, therefore it is only their views that are represented here. It is noteworthy that only a very specific demographic dominated the discussion, with very few younger people and very few women giving their input. Over-representation of older male participants has been observed in other studies as well[6,28]. While this might reflect the distribution of decision makers in the community, it is important to address this issue to achieve a broader and more future-proof support of emerging RECs.

The age and gender gap observed in all four workshops is a concern that warrants further investigation. Underrepresentation of the younger generation and of female participants will have an impact on long term acceptance of any measures being taken, therefore broadening the scope of existing and emerging RECs towards all demographics has to be encouraged to make a success of these initiatives.

Another limitation arises from the nature of small-town communities, where influential individuals tend to influence who is attending events and what topics are discussed. While this is a benefit when it comes to participant recruitment and the formation of RECs, there is also a danger that certain segments of the population are not reached and that their input is not considered.

Finally, COVID impacted the execution of the workshops by delaying them for several months. The time between the initial engagement with citizens and the final face-to-face co-creation workshops has been extremely long due to prevailing restrictions. It cannot be ruled out that these delays led to disengagement with the formation of the RECs, nor can it be ruled out that certain segments of the population did not attend the face-to-face events due to COVID concerns.

Conclusions

This study set out to address a key research gap in the development of RECs: the limited understanding of how participatory and co-creative approaches can shape tools that are not only technically robust but also socially responsive and trusted by local communities. By employing a co-creation methodology across four European demonstration sites within the LocalRES project, the research examined how citizens and local stakeholders articulate their needs, expectations, and concerns regarding REC support and planning tools.

The findings demonstrate that effective REC tool design must be firmly grounded in local contexts, real data, and community-specific requirements. Participants consistently emphasised the need for clear visualisations of energy flows, transparent and comprehensible financial information, and functionalities that support both individual and collective decision-making. Equally important were communication features that foster community engagement, build trust, and enable meaningful participation. The study also highlights the diversity of user preferences, ranging from digital platforms to paper-based formats, and the necessity of accounting for varying levels of technical literacy. Moreover, the workshops revealed that citizens view RECs as embedded in broader sustainability and community development concerns, suggesting that future tools should adopt a holistic perspective extending beyond energy alone.

Drawing on these insights, the study offers a set of concrete recommendations for the co-design of REC tools. These include adapting tool design to local conditions, providing layered interfaces for different user profiles, ensuring financial and technical transparency, integrating communication and community-building features, and enabling knowledge exchange between communities. Together, these recommendations outline a pathway for creating inclusive, trustworthy, and adaptable tools that can support the establishment, operation, and long-term sustainability of RECs in small-town European contexts.

Ultimately, this work demonstrates the value of co-creative approaches in shaping tools that are aligned with community needs and capable of empowering citizens in the energy transition. Future research should build on these findings by testing and refining co-designed tools in real-life REC deployments, further exploring how participatory design can strengthen energy justice, local capacity building, and collective governance in diverse community settings.

Data availability

Underlying data

OSF: European small-town Renewable Energy Communities: Participatory design of supporting tools as a vehicle to engage and understand local communities and their energy related concerns[26].

This project contains the following underlying data:

- ResearchData LocalRES Citizen Workshops.xlsx (data collected from participants via questionnaires during the workshops)

Extended data

This project contains the following extended data:

- ResearchData LocalRES Citizen Workshops.pdf (dataset description, including the questionnaire distributed to the workshop participants)

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

Acknowledgements

This work is the result of the joint effort of many people contributing to the LocalRES project and the preparation and

delivery of the four workshops. These are Christian Beder and Martin Klepal from MUNSTER TECHNOLOGICAL UNIVERSITY, Benjamin Horvilleur and Claire Lucas from ARTELYS, Carolina Pastor and Andrea Gabaldón from FUNDACION CARTIF, Bernd Strobl from MARKTGEMEINDE OLLERSDORF IM BURGENLAND, Rolf Eriksson from KOKAR KOMMUN, Niko Korpela from FLEXENS OY AB, Garbiñe Saenz from AYUNTAMIENTO DE ISPASTER, Iñaki Gaztelu from EZE BARRIZAR KOOP ELK TXIKIA, Irantzu Urcola from FUNDACION TECNALIA RESEARCH AND INNOVATION, Diana Vaz from AIGUASOL, Emilio Ghiani from COMUNE DI BERCHIDDA, Sara Ruffini and Raphaelle Papa from R2M ENERGY SRL, and Natalia de Assis Brasil Weber from AUSTRIAN INSTITUTE OF TECHNOLOGY.

Appendix

Community Goals

Table 4. Individual Community Goals for all four Pilot Sites.

	Berchidda	Ispaster	Kökar	Ollersdorf
Goal 1	Save on the cost of energy and maximise the return on investment	Supply all public buildings with 100% renewable energy	Increase renewable asset utilization across the community	Achieve 100% renewable energy for the community
Goal 2	Achieve energy self-sufficiency for the community	Energy self-sufficiency or positive energy system in the school	Achieve self-sufficiency on the island	Achieve energy self-sufficiency for the community
Goal 3	Enable freedom of choice to install equipment	Reduce the dependency on external energy supply, i.e. the main grid	Increase the reliability of the electricity supply on the island	Achieve energy supply security
Goal 4		Achieve energy autonomy of the town (excluding transport, due to reliance on private transport)	Facilitate increased demand for EV charging infrastructure on the island	
Goal 5		Promote more communal energy production and assets in addition to individual private initiatives		

Scenarios and potential questions for the planning tool to answer

Table 5. Berchidda Scenarios and Key Questions.

Scenarios	Questions answered by the planning tool
- PV is installed on public buildings, such as the elementary and middle school, the belvedere, the wine museum and the sports ground - 67 private dwellings currently have PV installed - Some commercial buildings have PV installations, e.g. the local winery or the cork factory	- What are the energy cost savings and the return on investment for a private PV installation? - What are the energy cost savings and the return on investment for a communal PV installation?
Up to 50 private dwellings are currently planning to install heat pumps and thermal storage	What are the energy cost savings and the return on investment for a private heat pump and thermal storage installation?
Rural communities in the surrounding area are currently planning to operate a micro grid and limit the exchange with the public MV grid	- What are the energy cost savings for the community that can be achieved through demand response and power purchase agreements? - What level of self-sufficiency can be achieved and how much energy needs to be exchanged with the grid?
- 4 public EV charging stations are planned to be installed - Up to 70 households are planning to install private EV charging infrastructure	- How many EV charging stations are feasible given the grid constraints? - What additional investments into the infrastructure are necessary to facilitate the freedom of choice in relation to EV charging stations for citizens?

Table 6. Ispaster Scenarios and Key Questions.

Scenarios	Questions answered by the planning tool
- The current school building is going to be completely rebuilt, including PV and a geo-thermal heat pump - It will become the largest energy prosumer in the community	- How much can passive measures, such as improved insulation, contribute to the energy demand profile of the school building? - How much PV and geo-thermal heat pump capacity is necessary to facilitate connecting the school to the local small-scale district heating network, and how many households can be supplied with heat?
- Currently 4 public buildings (school, sport centre, town hall, church) are connected to an electric micro-grid; more public buildings are to follow - All public buildings will be connected to a small-scale district heating network, with the option to also connect them to the electric micro-grid	- How many and which public buildings can be connected to the existing and the future heating network and electrical micro-grid? - How many private dwellings can be supported by the existing and future heating network and electrical micro-grid? - How would heat pumps connected to the micro grid compare to a connection to the district heating network?
Currently no community owned PV is installed in the village	- How many roofs on private dwellings are available for community owned PV panels, how much energy are these going to produce, and what would be the energy cost and return on investment for these installations? - How much community owned PV can be installed on public land and properties, e.g. the church or business park, and what are the shared benefits for the community?

Table 7. Kökar Scenarios and Key Questions.

Scenarios	Questions answered by the planning tool
- The Sommarängen nursing home and its kitchen is the biggest energy consumer in the area - It currently has PV, a battery, and a heat pump installed to meet some of its energy demand	- What additional assets or operational changes are needed in the nursing home to maximise its self-consumption? - How can the over-consumption and battery in the nursing home benefit private PV installations in the community by allowing to consume excess energy and thereby improve community level self-consumption? How much additional distributed PV capacity does this enable? - What additional CO2 savings can be achieved in the future by additional installation of PV capacity at the nursing home?
- The Mika wind turbine is generating approximately 50% of the island's electricity supply - The Sommarängen nursing home is maintaining an emergency Diesel generator for the island community	- What grid updates, communal or private storage capacity is required to keep the power supply from the Mika wind turbine connected, even if the mainland connection is down? - How much additional wind energy needs to be installed to make the island completely self-sufficient? - How can the battery installed in the Sommarängen nursing home help to avoid falling back on Diesel generation in case of a disconnection from the mainland power line? - How can private PV and heat pump installations contribute to keeping the communal batteries charged for these emergency scenarios?
- PV installed on the school building - Small wind turbine - Heat pump and power-to-heat storage system to be installed in the Karlby community centre to replace existing oil boiler	How many nearby households can be connected to a small-scale district heating system operated from the heat pump, PV and power to heat storage system installed in the Karlby centre? How much can the power to heat storage contribute to communal and private self-consumption, and how much energy needs to be imported from the grid? How much private PV generation can be stored in the power to heat storage system?
- 3 public EV charging stations available in Kökar - Private EV charging station across the island, e.g. 4 EVs are currently operated by Kökar service - Electric boats and cars will require a sufficient charging infrastructure in the future	- How many additional EV charging stations, both for cars as well as for boats, can be installed on the island considering the grid capacity? How many electric cars/boats does this facilitate? - How can vehicle-to-grid solutions provided in particular by electric boats not used during the winter months contribute to the island's energy system?

Table 8. Ollersdorf Scenarios and Key Questions.

Scenarios	Questions answered by the planning tool
PV is installed on public buildings, such as the town hall, fire station, GP surgery, EV charging station, primary school, kindergarten, church	- How much additional private PV installations are necessary to achieve 100% renewable energy supply? - How much additional communal PV generation is desirable? - How much energy needs to be supplemented through additional renewable generation, e.g. biomass?
Battery storage is currently installed in the town hall, the fire station and the church	- How much additional battery storage is required to achieve self-sufficiency? - How much of this battery storage should be communal, how much should be private? - How much battery storage is required to guarantee security of supply for households?
Battery storage is currently installed in the town hall, the fire station and the church	- How much additional battery storage is required to achieve self-sufficiency? - How much of this battery storage should be communal, how much should be private? - How much battery storage is required to guarantee security of supply for households?

References

1. Directorate-General for Internal Policies of the Union: **European policies on climate and energy towards 2020, 2030 and 2050**. 2019.
Reference Source
2. European Union: **DIRECTIVE (EU) 2018/2001 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2018 on the promotion of the use of energy from renewable sources**. 2018.
Reference Source
3. Neij L, Palm J, Busch H, *et al.*: **Energy communities—lessons learnt, challenges, and policy recommendations.** *Oxford Open Energy.* 2025; **4**: oiaf002.
Publisher Full Text
4. Caramizaru A, Uihlein A: **Energy communities: an overview of energy and social innovation**. 2020.
Reference Source
5. Wierling A, Schwanitz VJ, Zeiß JP, *et al.*: **Statistical evidence on the role of energy cooperatives for the energy transition in European Countries.** *Sustainability.* 2018; **10**(9): 3339.
Publisher Full Text
6. Hanke F, Guyet R, Feenstra M: **Do renewable energy communities deliver energy justice? exploring insights from 71 European cases.** *Energy Res Soc Sci.* 2021; **80**: 102244.
Publisher Full Text
7. Bauwens T: **Explaining the diversity of motivations behind community renewable energy.** *Energy Policy.* 2016; **93**: 278–290.
Publisher Full Text
8. Kalkbrenner BJ, Roosen J: **Citizens' willingness to participate in local renewable energy projects: the role of community and trust in Germany.** *Energy Res Soc Sci.* 2016; **13**: 60–70.
Publisher Full Text
9. Seyfang G, Park JJ, Smith A: **A thousand flowers blooming? An examination of community energy in the UK.** *Energy Policy.* 2013; **61**: 977–989.
Publisher Full Text
10. Berka AL, Creamer E: **Taking stock of the local impacts of community owned renewable energy: a review and research agenda.** *Renew Sustain Energy Rev.* 2018; **82 Part 3**: 3400–3419.
Publisher Full Text
11. **Horizon LocalRES project**.
Reference Source
12. Huang Z, Yu H, Peng Z, *et al.*: **Methods and tools for community energy planning: a review.** *Renew Sustain Energy Rev.* 2015; **42**: 1335–1348.
Publisher Full Text
13. Cumbula S, Sabiescu A, Cantoni L: **Co-design with communities. A reflection on the literature**. 2013.
Publisher Full Text
14. **Horizon ENPOWER project**.
Reference Source
15. **Horizon HESTIA project**.
Reference Source
16. **E2District EUProject**.
Reference Source
17. Ahmed S, Ali A, Ciocia A, *et al.*: **Technological elements behind the renewable energy community: current status, existing gap, necessity, and future perspective—overview.** *Energies (Basel).* 2024; **17**(13): 3100.
Publisher Full Text
18. Bâra A, Oprea SV: **Enabling coordination in energy communities: a Digital Twin model.** *Energy Policy.* 2024; **184**: 113910.
Publisher Full Text
19. Elomari Y, Mateu C, Marín-Genescà M, *et al.*: **A data-driven framework for designing a renewable energy community based on the integration of machine learning model with Life cycle assessment and Life cycle cost parameters.** *Appl Energy.* 2024; **358**: 122619.
Publisher Full Text
20. Horizon 2020: **Empowering local renewable energy communities for the decarbonisation of the energy systems**. 2021.
Publisher Full Text
21. Harrington C, Erete S, Piper AM: **Deconstructing community-based collaborative design: towards more equitable participatory design engagements.** *Proc ACM Hum-Comput Interact.* 2019; **3**(216): 1–25.
Publisher Full Text
22. Ramirez R: **A 'meditation' on meaningful participation.** *The Journal of Community Informatics.* 2008; **4**(3).
Publisher Full Text
23. Lee J, Lee D, Park Y, *et al.*: **Autonomous vehicles can be shared, but a feeling of ownership is important: examination of the influential factors for intention to use autonomous vehicles.** *Transportation Research Part C: Emerging Technologies.* 2019; **107**: 411–422.
Publisher Full Text
24. Kanji N, Greenwood L: **Participatory approaches to research and development in IIED:Learning from experience.** London: IIED, 2001.
Reference Source
25. Parker S: **The co-production paradox**. 2007.
26. Blanke J, González AB, D'Oca S, *et al.*: **European small-town Renewable Energy Communities: participatory design of supporting tools as a vehicle to engage and understand local communities and their energy related concerns**. 2022.
https://osf.io/v5xg7/
27. Horizon 2020: **Holistic dEmand response Services for European residenTIAl communities**. 2021.
Reference Source
28. Conradie PD, De Ruyck O, Saldien J, *et al.*: **Who wants to join a renewable energy community in flanders? Applying an extended model of theory of planned behaviour to understand intent to participate.** *Energy Policy.* 2021; **151**: 112121.
Publisher Full Text

Open Peer Review

Current Peer Review Status: ? ? ? ✗

Version 2

Reviewer Report 18 March 2026

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✗

Henny van der Windt
University of Groningen, Groningen, The Netherlands

Dear authors, without doubt, your paper has potential. Participatory design for RECs and local communities is an interesting and relevant topic. In addition, the paper is well structured and well written. However, I have some serious concerns.
First of all, the work is hardly rooted in literature and current discussions and findings on participation and RECs. The last 10 years, partly based on other European projects, at least 100 papers have been published about this issue, especially on participation, the role of participation compared to other factors, the role of national and local contexts, and the role of governments, including municipalities. Both more theoretical as empirical as practical types of papers are available. Tools are in use quite a long time and can be found on websites of REScoop and national umbrella organizations of RECs. Therefore, it is extremely important to define the research gaps precisely and to show the added value of the work, and its contribution to theory and practice. This means in my opinion that in introduction and discussion much more literature should be added.
Next, the methodology mentions the word coding without explaining how the coding process was carried out. Lease adds.
Third, it is said that the villages are remote and the RECs are small. Please explain what that means, comparing to less remote and larger RECs. This may be an interesting finding! They stem from various countries, and this is not discussed while it is known that national context is very important. See for instance the results of previous Horizon2020 projects, for instance the Comets project and the resulting papers
Fourth, I table 3 some results are listed, and in the conclusion section some conclusions, but most of is already known. So, specification is needed to show the added value.
All in all, I suggest serious adjustments to improve the embedment in existing literature, both empirical and theoretical, and to show the added value, also for practice.

Is the work clearly and accurately presented and does it engage with the current literature?
No

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

Are all the source data and materials underlying the results available?
No

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are the conclusions drawn adequately supported by the results?
No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Energy transition, social movements, energy communities, science and technology studies

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Reviewer Report 03 March 2026

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Mohammad Fazle Rabbi
University of Debrecen, Debrecen, Hungary

The paper examines how co-creation methodologies engage citizens in REC development, focusing on technical, economic, and social tool requirements. It employs qualitative analysis of workshop feedback from 64 participants across Berchidda (Italy), Ollersdorf (Austria), Ispaster (Spain), and Kårkå (Finland/Åland). The study offers moderate originality by synthesizing local insights into practical recommendations (e.g., Table 3 on tool design), relevant to EU energy transition policies like the Renewables Directive, though it builds incrementally on prior participatory energy research. Objectives are now clearly stated post-revision, with improved logical flow, but the contribution remains descriptive rather than theoretically novel, aligning well with open-access journals like Open Research Europe.

Major Issues

- Sample bias and representativeness: Workshops attracted only interested, predominantly older

male participants (e.g., >78% over 45, ~13% female across sites; Tables 1-2), risking skewed insights that overlook younger demographics, women, or skeptics; this limits generalizability to broader REC formation and could undermine long-term viability claims. Revise by discussing mitigation strategies (e.g., targeted recruitment) and sensitivity analyses.
- Methodological rigor in qualitative analysis: Thematic coding by single, language-fluent researchers per site lacks inter-coder reliability checks or explicit codebook, potentially introducing subjectivity; no quantification of theme frequencies despite 64 responses. Strengthen with multi-coder validation or software-assisted analysis (e.g., NVivo) and report theme saturation.
- Limited causal or comparative depth: Differences across sites (e.g., advanced Ollersdorf vs. nascent Ispaster) are described but not rigorously compared statistically or contextually (e.g., climate/island effects on goals); appendices detail scenarios well, but cross-site synthesis is narrative-only. Add a comparative table of site-specific feedbacks and test for patterns (e.g., via chi-square on demographics vs. priorities).
- Absence of tool validation: Recommendations (Table 3) derive from mock-up feedback, but no prototype testing or longitudinal follow-up assesses real-world impact on REC formation. Include plans for tool iteration and evaluation in future work section.

Minor Issues
- Inconsistent terminology: "Co-design" and "participatory design" used interchangeably without distinction; "planning tool" links to ENPOWER but lacks full specs. Standardize terms and provide a glossary.
- Figure/Table clarifications: Figure 1 lacks scale bar or energy data overlays; Table 3 could specify evidence sources (e.g., quotes per theme). Add legends and cross-references.
- Referencing and formatting: Minor typos (e.g., "Itiden Elverksgatan" likely "Itäisen Elverksgatan"); some references (e.g., project sites) are informal URLs. Proofread and use DOIs where available.
- Wording ambiguities: Phrases like "vague information and estimations were perceived as insufficient" need direct quotes for support; expand acronyms on first use (e.g., SME). Enhance precision with examples.

Methodological Evaluation
Participatory workshops suit the exploratory aim, with ethical approval, anonymous data, and open OSF repository enabling reproducibility. Preparatory online sessions informed tailored questionnaires/scenarios (Appendix Tables 4-8), appropriately qualitative-focused post-revision (stats removed). However, no pre-testing of instruments, single workshops per site, and self-selected recruitment compromise controls and representativeness; aligns with co-design standards but falls short of mixed-methods rigor in social innovation literature. Data translation/coding is transparent but could detail exclusion criteria for comments.

Interpretation and Discussion Quality
Conclusions coherently link results to the research gap (e.g., holistic tool needs), supported by categorized feedbacks (technical/financial/social) and Table 3 recommendations. Interpretations avoid overclaiming, acknowledging limitations (bias, COVID delays), and contextualize within EU barriers (e.g., finance, trust). Minor oversimplification: Broader sustainability links (e.g., food/water) are noted but not evidenced quantitatively; future research suggestions are apt but could quantify potential impacts.

Organization and Presentation

Structure is logical (Intro-Methods-Results-Discussion-Conclusions-Appendix), with balanced sections and improved revisions (e.g., expanded Intro). Writing is clear, formal, and readable, with effective tables (e.g., demographics, goals) and plain-language summary. Figures are relevant (e.g., sites map), but legends could better sync with text (e.g., workshop photos if included); consistent EU policy framing aids flow.

Is the work clearly and accurately presented and does it engage with the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

Are all the source data and materials underlying the results available?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Energy systems modeling, renewable energy communities, participatory design in sustainability, EU energy policy, and qualitative analysis of citizen engagement in energy transitions.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Version 1

Reviewer Report 17 July 2023

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Noelia Romero-Castro
[1] Universidad de Santiago de Compostela, Santiago de Compostela, Galicia, Spain
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The article presents an interesting study, but it lacks scientific rigor in its structure and argumentation. Objectives are not clearly set, and results seem not very meaningful because objectives are not clear.

The introduction should try to identify a research gap in previous literature about CREs that this study is aimed at addressing. Please consider also reordering some parts of this introduction to give a more coherent argumentation of the aims of the study: first identify a research gap, then clearly set the objectives of the study, then explain in which context and with what methods are you going to serve those objectives.

I consider that the objective of the study is not clearly presented. In this phrase in the introduction it is explained in this terms: “In the following article we will describe an approach for how to engage and collect relevant input from the communities to enable the co-design of supporting tools considering local structures and requirements”. But in the methods section, the authors seem to offer the idea that the workshops developed are aimed at creating or validating a support tool: “...It was mentioned that the mock-ups were only meant as an idea for what the supporting tool could look like and that based on the outcomes of the workshops it will be adapted to the needs and requirements of each community...”. In the questionnaire used in the citizens workshops some questions are related to the presentation of a planning tool, but any information about the design of that planning tool is provided in the article. Some more structured information about the intended design of a support tool should be provided either in the introduction or in the methods section, or both.

Maybe some mention should be done to the specific content of Figure 1, where it seems that the authors have tried to identify the main motivations or objectives under each CRE. After reading the whole article, it seems that this goal identification is, in fact, one of the results from the workshops, so I wonder whether it has sense including those goals in a Figure that is part of the introduction.

Maybe some mention to the LocalRes project should also be done in this introduction before the one made in the last paragraph, since after presenting the four communities involved in the study a mention is made to the pilot character of one of them without clarification about it. It is not clear which is the development state of each one of the four CRE projects. Are all in the same phase? It seems that some information on this regard is offered in the results section, but it should be moved to the introduction or methods sections. Maybe some comment about how the differences among the four localities can condition the development of the CRE projects would be welcome (for instance, differences in size, or being or not an island...).

If a specific literature review or conceptual background section is not envisioned for this article, then I would recommend adding some more references to previous research in the introduction. I also have doubts about the pertinence of keeping the first subsection of the methods section there, since it is in fact a literature review about co-creation and participatory processes in CREs. Some more ideas would be relevant, for instance, which kind of barriers can be found in the formation processes of CREs, what role does the municipality play, etc. Please consider

concentrating this information in a specific literature review section.

Some more information about the type of involvement of citizens in each CRE project should be also provided: are they asked to invest a big or any amount of money? Could they be involved in other ways such as with voluntary work or similar?

Regarding specific issues presented in the methods section:

- In which specific phase of each pilot CRE were the workshops involved in the study developed?
- In the preparatory representative workshop, how a citizen representative was elected and with which profile (member of the municipal government or other).
- In the citizen workshops, is there any information about how participants are willing to contribute to the CRE project (invest money, voluntary work...)?

Regarding the results, I am not sure that they are representing or complying with any of the assumed objectives of the paper, since in the first subsection they limit to describe the debate about the goals, motivations or main interests of citizens in the four CRE projects, and in the second subsection lots of topics appear that had not been previously addressed specifically, either in the introduction or methods section (energy flows and balance, preferred mode of presentation, costs and expected return on investment, feasibility studies, etc.). I consider that previous sections should have referred to these issues that I guess are related to the design of the mentioned support tool. On the other side, there are not specific information about scenarios (which kind of scenarios were presented in the workshops, how were they defined, which variables were involved), but the article talks about the discussion with citizens about goals and scenarios. As already mentioned, there is a lack of clarity in the objectives, the methods, and the results of the study.

Moreover, although the authors acknowledge in the methods section that some quantitative information was gathered in the workshop, and it seems that they have conducted some kind of statistical analysis (since regarding the Berchidda project they mention these data in the Characterisation of the citizen workshops section “t(24.93)=2.25, p=0.03”, and there are some other similar extracts in the Feedback of workshop participants section), there are no formal statistical results presented. Consider presenting them in a structured (tabulated) form.

Maybe some comment about how the differences among the four localities can condition the goals identified would be welcome (for instance, differences in size, or being or not an island...).

Is the work clearly and accurately presented and does it engage with the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

Are all the source data and materials underlying the results available?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Sustainability, entrepreneurship, accounting and finance

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 21 December 2022

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The article addresses the social and community dimension of the challenges of the energy transition. It is clear and concise and has addressed some of the limitations. However, it needs more detailed information on the workshops. For example, how the workshop was conducted, whether participants were in groups or they formed one whole group. In addition, it would be helpful to include a breakdown table for the participants and their backgrounds, for example, how many were local energy experts. In addition, including how the results were analysed, the reason and explanation for using t-tests, and a brief explanation of what the numbers indicate. Also in presenting the results, including a comparison table for all four Eu communities. Then the reader can clearly see the differences.

Is the work clearly and accurately presented and does it engage with the current literature?
Yes

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

Are all the source data and materials underlying the results available?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Energy efficiency and sustanability, Energy prediction and optimisation, net-zero decarbonisation.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.