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A cooperative of their own: Gender implications on renewable energy cooperatives in Germany

Irmak Karakislak [a,b,*], Pantea Sadat-Razavi [a], Petra Schweizer-Ries [a,c]

[a] Department of Environmental Psychology, Institute for Future Energy and Material Flow Systems, Altenkesseler Straße 17, Geb. A1, 66115 Saarbrücken, Germany
[b] Center for Evaluation, Department of Sociology, Saarland University, Campus, Geb. C 53, 66123 Saarbrücken, Germany
[c] Integrated Institute for Sustainable Development, Bochum University for Applied Sciences, Am Hochschulcampus 1, 44801 Bochum, Germany

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ABSTRACT

Renewable energy cooperatives are crucial for local communities to initiate energy transition. With a mixed-methodological approach, this paper analyses the participation of women in renewable energy cooperatives in Germany and reveals the socio-cultural barriers. This study presents an intersectional analysis that integrates gender with other socio-cultural categories and identities within the social context of cooperatives. This study presents the results from a sex ratio analysis of energy cooperatives (N = 388), online interviews (N = 161), and semi-structured interviews (N = 9). Results show that a lack of awareness of opportunities, financial resources, and time for volunteer-based workload and the lack of recognition of social inequalities in the cooperatives hinder women from actively taking part in leadership roles. This study concludes by discussing how contribution to localised renewable energy production reflects differently on genders. It also provides suggestions such as mentorship and diversity programs that would allow more women to take management roles and encourage a more inclusive and fair transition for all.

1. Introduction

The world must find solutions to better mitigate and adapt to climate change. The energy transition is a central pillar of climate action that supports a sustainable shift in the energy systems [1]. The socio-technical change aims to diffuse low-carbon energy technologies. This challenge should be reinforced by policies, industry, and changing the behaviour of society [2,3]. Shifting from fossil fuels to renewable energy technologies has social, political, and cultural effects on societies. Changes to the energy sources and uses of the technologies create differences in societal practices and behaviours, such as using LED light for energy efficiency and travelling by train instead of flying [4]. Moreover, the geographical division of these changes in the energy systems tends to create uneven development in different states or regions, which impacts energy politics [5]. This transformation of energy production needs to be achieved on different scales [6]. Local and decentralised energy development is one of the pathways for sustainable energy transition [7,8].

Communities have several different meanings in the energy transition, from actors that have agency to take actions for the local governance of localities that carry out environmental applications [9]. Participation of local communities in the energy transition contributes to the shift in the energy systems and increases the acceptance of renewable energy technologies [10–12]. Addressing the barriers and local factors, such as norms and working with the communities to implement energy technologies can avoid opposition and build bottom-up solutions [13]. Renewable energy communities are groups of citizens and other stakeholders that actively and financially participate in local energy production and distribution [14,15]. These local groups could be formed and defined as energy communities [16], energy citizens [17] or energy cooperatives (co-ops) [18]. Overall, the goals of these forms are to consolidate local governance of renewable energy production and contribute to energy democracy and more justice [19–21].

A transition towards low-carbon energy requires a mix of large-scale and centralised energy systems with decentralised and bottom-up approaches for technology implementation [22]. German energy transition (*Energiewende*) is one example that integrates community-level energy production deployment into their energy system [23]. Consequently, political, technological, economic, and social changes affect the country's energy landscape. Germany's energy co-op form of community-led initiatives has a unique structure that allows allocating power shares through public participation [24]. However, local energy governance and public participation do not always guarantee fairness or equality for

* Corresponding author at: Altenkesseler Straße 17, Geb. A1, 66115 Saarbrücken, Germany.
E-mail address: karakislak@izes.de (I. Karakislak).

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all [25,26]. How people evaluate the fairness of an energy project depends on various factors [27]. Notably, gender justice issues are related to many other inequalities in energy systems, such as poverty and lack of recognition or representation in decision-making processes [28,29].

Energy research addresses a critical gap that investigates the practices and involvement of genders in the energy transition, such as the distribution of power inequalities [30,31]. Thus, more qualitative and quantitative data on the gender-energy connection could uncover the differences and relations between sexual categories. These different gendered groups hold a variety of responsibilities regarding environmental decisions; therefore, the issues dealing with energy transition need to tackle gender with greater attention [32]. Moreover, recognising a gender-aware perspective can contribute to a more sustainable, inclusive and diverse energy transition [33]. Thus, engendering energy policies that consider reoccurring inequalities, capabilities, and vulnerabilities would recognise and address the needs, as well as different energy practices, of socio-cultural identities [28].

Several researchers have conceptualised gender with its diverse aspects. More commonly, Butler [34] argues that gender is *culturally constructed* and does not only result from the sex given at birth. In the gender-energy nexus research, the definition of gender emphasises a social construct that may vary across social, cultural, economic, and political contexts [28]. Furthermore, some studies differentiate the gender dimensions as only men and women merely based on sex, which is enforced by heterosexuality [35]. However, we approach the intersections of gender and sexual identities by considering the socio-cultural context of the research site and existing power differences within genders.

Intersectionality, as the socially defined dimensions of gender, class, racial ethnicity, or sexuality, is an approach to grasping and recognising the inequalities and vulnerabilities within social systems that emerged from Black feminist theory [36,37]. Environmental research also aims to understand energy systems and climate adaptation by engaging with intersectionality theory [38,39], which explores these interlinked dimensions. Therefore, critically disintegrating the gender category to have *seriality*[1] would consider the common attributes of women, but it does not identify them as a homogeneous group [35]. In other words, the seriality of gender here does not exclude the individual identities of women [35]. Therefore, the social group of women should not be overgeneralised.

Studies show that women leaders in company boards tend to be more effective at pursuing environmentally friendly strategies [40]. Similarly, in the renewable energy industry, women are more concerned with the care for the environment, awareness of gender structures and the need for improvement [41]. Nevertheless, renewable energy planning and deployment institutions often follow patriarchal organisational patterns with hierarchical, male-dominated power structures and privileges [42,43]. Whether the technology development is centralised or locally rooted, social implications differ in geographies. Their decentralised and less hierarchical structure makes local German energy projects interesting [44]. However, renewable energy co-ops contain socio-cultural barriers preventing inclusive participation for women [45]. Similarly to *Windfang FrauenEnergieGemeinschaft*, an all-women-led wind energy co-op in Germany [45,46], there could be more cooperatives of their own.[2] Thus, this paper mainly targets the underrepresented social groups of women in local energy governance. With this, we propose to get further insights into local energy development and new potentials for its acceleration.

A growing body of research has delved into decentralised energy production and its socio-economic implications for the communities, like increasing technology acceptance or creating added value in the region [47–49]. However, there is still a research gap focusing on gender, intersectionality, and renewable energy governance [50,51]. By exploring the gender-energy nexus, this paper makes an intersectional analysis of renewable energy co-ops in Germany to fill this gap. This paper aims to question and further explain whether renewable energy co-ops in Germany are concerned with inclusive representation, participation, and decision-making practices.

In this study, we aim to answer the following questions: i) How is the recognition of genders in renewable energy co-ops addressed, and what are the social implications of this (mis)recognition? ii) What role do women play in the distribution of participation, involvement and leadership in renewable energy co-ops?

2. Theoretical background

2.1. Gender justice and energy transition

The notion of *no climate justice without gender justice* emerged in social protests for protecting the environment [52,53]. In contrast, social research has studied gendered experiences of environmental issues for decades. Research on attitudes and behaviours towards socio-technical change has become an essential subject of analysis, predominantly in quantitative studies [54]. The relationship between gender and environmental concerns [55], risk perceptions on health [56,57], and women's place in environmental justice movements [58] are some of the prominent research topics. However, eco-feminism captures the broader patriarchal power structures of gender attribution and different socio-cultural identities in environmental issues [59]. In this sense, an alternative feminist approach to gender justice requires the recognition of the social and cultural status of women in social interactions [60].

Feminist political theory reconstruct issues of gender justice with three dimensions; *redistribution*, *recognition* and *representation* [61]. Recognition for pushing for feminist claims in gender disparities, redistributing, and reframing disputes about justice should integrate into this reconfiguration of gender justice [61]. Moreover, Fraser's definition of *participatory parity* aims to provide a normative approach for evaluating justice for all social arrangements creating a base for the notion of justice [61]. This term identifies and evaluates justice with the recognition and distribution dimensions that also allow multiple axes of social differentiation. Therefore, this approach intends to create a non-identitarian model [60]. Thus, these three clusters of justice should be carefully examined in order not to reproduce gender exclusions in the same way.

Representation, especially in a political context, aims to extend visibility and legitimacy for women. However, in feminist theory, this term should also function as a language that fully or adequately represents *women* [34]. Butler explains that gender "intersects with racial, class, ethnic, sexual, and regional modalities of discursively constituted identities," making it impossible to detach from political and cultural conditions [34]. Sex (as assigned at birth) and gender (social and cultural identification) concepts have "multiplicity, fluidity and context-dependence", as Lykke argues [62]. Additionally, women are not a homogeneous group and can be affected by inequalities differently [63,64]. Therefore, there are diverse approaches to gender. Taking women as a homogeneous group with an essentialist position would fail to capture these differences, which we aim to be careful of while analysing the data. We acknowledge that this paper has a Western perspective. Moreover, we include the gender and sex construct both as assigned at birth (female) and as a socio-cultural category of individuals (woman) in our analysis.

Women are exposed to the negative implications of energy sources as much as men, yet still are mostly excluded from the decision-making practices on national and local levels [30]. Thus, another recognition

[1] Young defines *seriality* as a way of thinking about women as a social collective without assuming all women to have common or similar social attributes [35].

[2] Inspired by the essay of Virginia Woolf "A Room of One's Own" (1929) that argues a woman needs to have financial and social independence to gain intellectual freedom.

layer is different income levels, which are crucial for assessing energy-related issues such as energy poverty and access [54,65]. Some studies have explained women's primary motivation to participate in environmental movements to protect the family and future generations [52,55]. However, overgeneralising this goal could distract from institutional power relations that need to be uncovered [66].

Technocratic policymakers tend to assume energy topics to be gender-neutral, which creates a disconnection between energy and gender policies [64]. However, analysing gender relations in energy policy documents is a crucial consideration for gender equality [54]. Thus, not considering the relevance of gender in energy technologies to meet equality and empowerment goals hinder gender blindness in energy policies [67]. By addressing unequal social, cultural and institutional structures, gender mainstreaming seeks strategies for change [68]. Gender mainstreaming as an economic policy goal in the energy field aims to accelerate women's economic empowerment. Furthermore, it provides an analytical approach to recognising the presence of gender biases [63].

The current social inclusion policy in the United Nations (UN) Sustainable Development Goals,[3] alongside gender mainstreaming, has influenced international policy commitments. Since the 1970s, gender discourses have been discussed in the UN Conferences as women empowerment, followed by gender mainstreaming and finally led to social inclusion claims in the 2010s [28]. In their study, Clancy and Mohlakoana [69] show the direct and indirect effects of audits that put gender on the policy agenda and mainstreaming in the energy sector with data from Kenya, Senegal, and Nepal. However, operationalising inclusive practices according to the gender-aware policies in the energy field is seemed to have a slower transition. This study takes a gender justice approach to address the organisational patterns and norms that have been argued to redistribute power and create misrecognition [60].

2.2. Renewable energy co-ops as social systems

The role of energy co-ops in the energy transition is to provide innovative social structures and adopt low-carbon energy technologies to local conditions [24,70]. The most common legal forms of community-led renewable energy projects in Germany are limited partnerships with a limited liability company as a general partner (GmbH & Co. KG) and co-ops (eG) [20,49]. Renewable energy sources in Germany shared 45.4 % of the total electricity production in 2020 [71]. In 2019, private individuals owned 30.2 % of Germany's total renewable energy production.[4] Currently, 835 co-ops hold a total share of 3.5 % of renewable energy production.[5] Co-ops aim to promote energy production and consumption through local citizens buying and investing in renewable energy technologies. [72]. A group of community members initiate these co-ops and actively participate in the decentralised energy transition. Energy co-ops in Germany mainly rely on solar energy and much less on citizen-owned wind parks (*Bürgerwindparks*) [24]. Besides, many bioenergy villages and regions in Germany intend to cover the energy demand with biomass by operationalising decentralised bioenergy infrastructures [73].

Citizens of a municipality co-finance energy co-ops, and their power plant's equity is distributed individually [74]. Renewable energy co-ops have a democratic governance structure with the motto of "one-member-one-vote", regardless of the size of the shareholding [24]. This structure allows the division of the net earnings pro-rata among the members instead of according to their shareholding, which makes it convenient for new members to participate [49].

Feed-in tariffs (FiT), one of the leading investment models, are market-independent mechanisms exempt from volatile electricity prices [20]. This tariff provides strong investment security for small actors like co-ops. With the recent changes in the German Renewable Energy Act (EEA), the yearly number of newly founded energy co-ops in Germany is dropping [70]. However, localised energy production opportunities are threatened by the decrease of FiT and the introduction of new auction models in the EEA, [75]. The co-ops struggle to attain land tenure by competing with the investor companies [49]. Lack of knowledge, conflicts in the community, insufficient financial resources and institutional structures, and high competition in local energy markets are some barriers to developing renewable energy co-ops [70].

Participation in community energy projects primarily has two types: active participation by volunteering and financial investment [44]. Local community members can actively participate by buying shares from the co-ops or volunteering. In energy co-ops, board members organise and manage the projects as unpaid volunteers while still having financial investments [42,44]. Becoming a member of an energy co-op does not require any special skills or technical knowledge [45]. Renewable energy co-ops are mainly homogeneous regarding their members` demographic characteristics. Despite the gender-related differences (e.g., pay gap, occupational segregation between women and men [42]), there is homogeneity in the age and socio-economic status of the co-op members [76]. Most of the members in Germany are well-educated men with medium- to above-average incomes with normative motivations such as environmental concerns [20,24,77]. Nonetheless, women have limited involvement in energy governance as managers due to the patriarchal structures of men-dominated culture [67]. Therefore, questions of justice and homogeneity of the co-ops carry an essential role in integrating the interests of different social groups [20].

It is crucial to ensure the participation of diverse social groups by keeping the minimum financial engagement low enough to support the social acceptance of the technologies [70]. For example, *Windfang* in Germany aims to increase women's work experience in energy projects [45,46]. Their board members have financial compensation for their work, despite the co-op's unpaid voluntary work tradition in Germany [78].

Identifying the differences in participation between women and men can affect decision-making and policy outcomes [54]. Standal et al. found that prosumers[6] were often described as men interested in technology, whereas women have environmental motivations to become prosumers [80]. Additionally, companies with more women board members tend to prioritise and invest in renewable energy and commit to lowering their carbon emissions [81]. Classification of energy technology as technical and *masculine* creates further barriers for women to engage in these fields or address their needs [54]. Some studies argue that women who enter male-dominated power and privilege structures tend to act according to traditional *masculine* norms [82]. This contradiction creates the danger of not being able to fully represent women's interests in the decision-making spheres. Policies on changing energy behaviour may affect genders disproportionately due to unequal circumstances (e.g., household workload) [83]. Therefore, women's engagement in designing policies is one aspect of building gender into the energy transition.

2.3. Intersectionality in environmental research

Intersectionality has emerged as a critical framework and paradigm, especially in post-structural feminist, Black feminism and queer theory

[3] https://sdgs.un.org/.

[4] Source: Renewable Energies Agency — Ownership distribution of installed RE capacity for power production in Germany in 2019 https://www.unendlich-viel-energie.de/studie-buergerenergie-bleibt-zentrale-saeule-der-energiewende.

[5] Source: The German Cooperative and Raiffeisen Confederation — Annual survey of energy cooperatives https://www.dgrv.de/news/dgrv-jahresumfrage-energiegenossenschaften/.

[6] Prosumers are actors that consume and produce renewable energy (see [79]).

[84]. The feminist movement has evolved using this concept, especially with anti-racist and post-colonial commentary on mainstream feminism [62]. Intersectionality offers an analytical tool for the interactions between gender, racial ethnicity, social status, and other social and cultural categories of individuals that reflect on the social practices, institutional contexts, and the outcomes of these power dynamics [37]. Power relations within social categories set the ground for injustices in various ways. Therefore, understanding these structures, norms, and dynamics between interactions of social identities proposes reframing these injustices [85].

Intersectionality in energy systems has the potential to identify the challenges and barriers that distribute power and injustices [38]. The climate justice movement in North Dakota, US, started as an indigenous movement and moved beyond to a collective resistance and liberation across social groups (as LeQuesne calls the "matrix of resistance") [86]. One study by Nygren and Wayessa [87] examined the displacement of marginalised communities in cities in Mexico and Ethiopia. Their study showed that an intersectional approach provides nuanced dimensions of environmental injustices while highlighting how institutions reproduce this displacement [87]. Thus, better accounting for intersectional nuances in environmental research can lead to more critical solutions and responses to injustices [39].

2.4. Conceptual framework

The environmental justice framework by Schlosberg argues that social and individual recognition are key elements of attaining justice alongside distributive and procedural dimensions [88]. This framework recognises inequality, participation, and capabilities of individuals and communities instead of arguing for an all-inclusive theory of justice [88]. This study proposes an interlinked workable conceptual framework with a similar goal (see Fig. 1). This study investigates the German renewable energy co-ops by adapting Fraser's three clusters of gender justice (i.e., redistribution, representation, recognition) and integrating them into: *participation*, *management roles* and *socio-cultural barriers*.

In this study, we investigate women's active and meaningful participation. Rau et al. [89] describe four levels of participation in renewable energy technologies: information, consultation, cooperation, and citizen control. Even though participation is not a guarantee of acceptance, active engagement opportunities for planning and decision-making motivate the public [89]. The degrees of citizen power that enable decision-making, partnership, delegated power, and citizen control are aspects within energy communities and co-ops [18,90].

We are examining the representation of genders in these leadership roles. In Germany, renewable energy co-ops (*Energiegenossenschaften*) have an Executive Board (*Vorstand*) and Supervisory Board (*Aufsichtsrat*) that are responsible for management. Both board memberships are mostly voluntary [47]. Supervisory Board (SB) members usually elect the Executive Board (EB) members. EB members are responsible for managing and representing the co-op in project development, finance, membership, and administration. SB members supervise, monitor and advise the EB in the members' interests. The General Assembly of the co-op includes every legal member and elects the SB members.

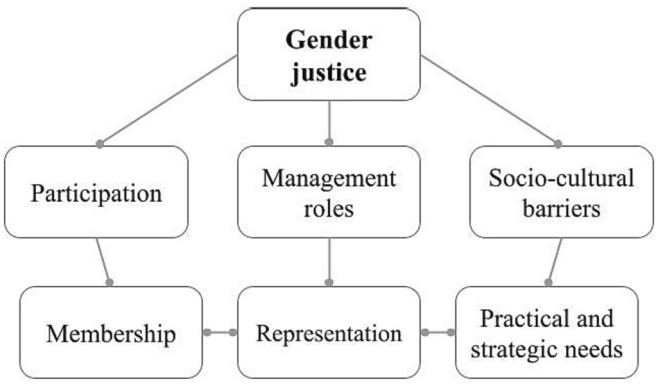

Fig. 1. Conceptual framework of the study.

Studies show socio-cultural barriers for women in renewable energy, including involvement in energy communities or co-ops [42,91]. Energy co-ops in Germany serve a relatively homogeneous social group, leaving several other groups underrepresented. The co-ops decision-makers consist of older men who share different responsibilities in their work and personal life compared to women. This study aims to identify these barriers in German energy co-ops to develop and discuss measures to include women's claims as one underrepresented group. In this context, we consider women involved in energy co-ops who would be interested in participating and taking a role in the management and women that would be potential co-op members. Furthermore, we analyse the institutional structures of co-ops and whether it allows flexible opportunities for women and considers their needs. Their needs may differ due to gender pay and care gap.

3. Research methodology

This study has a mixed-methodological approach, taking quantitative and qualitative data to investigate women as an underrepresented group in co-ops. First, the aim has been to show the distribution of women in participation and leadership of renewable energy co-ops and, second, examine the perspectives and experiences of energy co-op members on this topic. The methods used in this study complement each other to answer the research questions.

3.1. Research hypotheses

Increasing the representation of women and opportunities for diverse social groups would contribute to a more inclusive and fair energy transition. Thus, we assume the following hypotheses for German energy co-ops:

Co-op members elect the management boards. However, board members have the power to make decisions about project development and other administrative tasks. Therefore, investigating the female-to-male ratio in co-op boards can reveal gender representation and relations.

H1. : Women are underrepresented in the Executive and/or Supervisory Boards of renewable energy co-ops.

There are more investments from men than women for financial citizen participation in renewable energy in Germany [42]. We argue that co-op membership is more attainable and attractive for men than women.

H2. : People involved in renewable energy co-ops evaluate the participation and involvement of women to be low.

Co-ops are social systems that have members mainly from local communities. They serve as a social phenomenon investigating community identity, collective action and social relationships [24]. Also, decision-making in co-ops is democratic, which requires the board members to distribute their delegated power. This study considers the relationship within the co-ops as an essential indicator for investigating the dynamics of participation.

H3. : Co-op members evaluate the relationships in the co-op structure to work well (e.g., communication between the board and the members, distribution of responsibilities).

Justice being a socio-spatial phenomenon, its claims must be understood within the social and political context while considering broader implications [87]. Various topics create inequalities for women (e.g., gender pay gap, division of household work, gender norms), and this study investigates the circumstances in the German energy

transition.

H4. : Women members of renewable energy co-ops face more participation obstacles than men.

Co-ops in Germany currently have a particular member profile (mostly older men from the middle to upper class) [42]. This study argues that co-ops typically do not recognise and consider inclusion and diversity aspects.

H5. : Members rate the renewable energy co-ops' diversity and consideration of women's needs to be low.

3.2. Research design

To address the research questions and test the hypotheses, we collected qualitative and quantitative data with a female-to-male ratio of energy co-ops (N = 388), a standardised online questionnaire (N = 161) and semi-structured online interviews (N = 9). This mixed-methodological combination has the strength of gaining a more comprehensive understanding of the concept [92]. We collected all the data between December 2021 and April 2022.

In energy social science, mixing methodologies play a pragmatic role as alternative research designs that aim to reveal underlying dynamics [93,94]. Furthermore, using a pluralistic approach in intersectional research significantly affects theoretical discussions and methodologies [62]. The choice of methods can benefit from an open approach to understanding gender as a changing and contextual social characteristic [62]. We explored the scientific and grey literature to overview the female-to-male ratio in energy co-ops in Germany. We realised the gap in this data that relates to our research questions. Later, we wanted to examine this inequality in representation further to discuss its reasons and solutions with individuals already involved in energy co-ops.

3.2.1. Sex ratio analysis

First, we analysed the sex ratio of EB and SB members in German renewable energy co-ops. We searched for co-ops in the common register portal of German federal states with the keyword "energy" (*Energie*), which resulted in 248 entries. Furthermore, we scanned the lists in umbrella organisations of federal states such as BürgerEnergie Thüringen e.V., Energiewende Baden-Württemberg, Energieagentur Brandenburg and others that had similar platforms.

This research resulted in 388 registered renewable energy co-ops in 16 German federal states. We extracted the information from the publicly available data (names of the board members) on the websites of the co-ops or the company registration websites. We have included and analysed the sex ratio of EB (N = 1012) and SB (N = 1367) members of German energy co-ops. Our analysis included co-ops that produce wind, solar and biogas energy, and develop bio heating systems and ecovillages. We statistically analysed the ratio of females to males in our sample group. We want to highlight that this dataset does not consider the complexity and diversity of sexual identities due to data collection limitations. As there was no available data, such as an online map or list of all the registered co-ops in Germany, these results are based on the names and pictures of the board members from the 388 scanned co-op websites. Therefore, it does not consider the personal gender identification of the included board members.

3.2.2. Online survey

We prepared an online survey for data collection. We distributed the survey to umbrella associations, organisations and over 300 registered German renewable energy co-ops with an email containing the link to the survey and an explanation of our research interests. We could reach out to only the co-ops with publicly available information through their websites (N = 388). We collected some socio-demographic information from the participants but did not ask any questions about personal data (e.g., name, address) that could identify individuals or co-ops. Therefore, participation in the survey was ensured to be voluntary and anonymous. Participants could drop out of the survey without any consequences.

The survey has three sections. The first section asks the respondents their role, motivations, and involvement with the co-op by single or multiple selection questions. Furthermore, we asked how much total investments the participants had in their co-op and whether they allocated weekly hours to co-op activities depending on their role.

The second section collects data for verifying the hypotheses on the perceptions of gender equality in their co-ops. With a 5-point Likert rating scale, we measured how respondents rated gender equality in renewable energy co-ops. Scale points were anchored with the words "very good", "good", "average", "poor", and "very poor" or "always", "often", "sometimes", "rarely", and "never". We asked them to rate the participation of women among the co-op members, their experiences of being members, and the co-ops' openness to potential members. Finally, the last section collects the socio-demographic information of the respondents, such as age, gender, education level, occupation and annual household income (see Supplementary files).

3.2.3. Semi-structured interviews

We conducted semi-structured interviews with stakeholders in renewable energy co-ops in Germany. We had interviews with EB and SB members from four co-ops in Germany that accepted our invitation. We interviewed nine stakeholders (two women and seven men) from eight renewable energy co-ops with snowball sampling (see Appendix). We assured interview participants anonymity, asked for their consent and declared this study's ethical considerations and data protection principles with an information sheet. The interviews aimed to identify in detail the differences and similarities between men and women and other demographic variables, attitudes, and behaviours within the co-ops.

Moreover, we interrogated what socio-cultural barriers women face with their external relations with other groups in the renewable energy sector, such as public authorities, permitting and planning institutions. Finally, we discussed programs, training and actions that some co-ops used to support diversity in their members. Some questions were: "What do you think are the advantages of being on a co-op board? Did you face any challenges while becoming a member? Does your co-op have any measures to increase the number of women members?" All interviews were conducted through online meeting tools, transcribed and analysed using MAXQDA data management software.

3.3. Measurements and data analysis

The evaluation of the survey data was carried out with the statistical software SPSS. Cronbach's alpha (α) tests were carried out to assess the reliability of the measurements. When α was higher than 0.6 or 0.7, the questions were combined to indicate one measurement of the variables. The descriptive statistics and correlations for all measurement items and variables used for the scale questions are summarised in Table 1.

The variables were asking the participants to rate their participation experience (1), the openness of their co-op to potential members (2), participation of women (3), awareness of personal conditions (4), consideration of women's needs (5), measurements to support diversity (6), the relationship between the board and the members (7), and the distribution of responsibilities within the co-op (8). Lastly, we asked the respondents to select the extent of similar opportunities for genders (9) and the barriers women face (10).

The means and standard deviations of the responses from women and men participants were not significantly different from each other according to the independent *t*-test. As only one participant identified as another gender (non-binary) in the survey and the sample was too small to include in the statistical interpretation, we will not discuss their responses separately.

We investigated the institutional governance of co-ops with an intersectional approach. We focused on women's participation,

Table 1
Means, standard deviations, and variable correlations.

Variable	M	SD	1	2	3	4	5	6	7	8	9
1. Experience	1.66	0.708									
2. Openness	1.66	0.698	0.475** [<0.001]								
3. Participation	2.75	0.989	0.061 [0.432]	0.165* [0.036]							
4. Awareness	2.22	0.724	0.430** [<0.001]	0.360** [<0.001]	0.193* [0.014]						
5. Consideration	2.39	0.837	0.297** [<0.001]	0.362** [<0.001]	0.386** [<0.001]	0.620** [<0.001]					
6. Measures	2.40	0.824	0.216** [0.006]	0.367** [<0.001]	0.364** [<0.001]	0.486** [<0.001]	0.715** [<0.001]				
7. Relationship	1.86	0.660	0.497** [<0.001]	0.492** [<0.001]	0.241** [0.002]	0.446** [<0.001]	0.372** [<0.001]	0.371** [<0.001]			
8. Responsibilities	2.19	0.875	0.416** [0.001]	0.492** [<0.001]	0.192* [0.014]	0.319** [<0.001]	0.311* [<0.001]	0.294** [<0.001]	0.588** [<0.001]		
9. Opportunities	1.50	0.815	0.199* [0.12]	0.053 [0.503]	0.150 [0.057]	0.245** [0.002]	0.277** [<0.001]	0.193* [0.014]	0.168* [0.034]	0.001 [0.992]	
10. Barriers	3.86	1.069	−0.194* [0.014]	−0.104 [0.191]	−0.089 [0.277]	−0.235** [0.003]	−0.269** [<0.001]	−0.199* [0.011]	−0.143 [0.071]	−0.186* [0.018]	−0.388** [<0.001]

N = 161. *M* and *SD* are used to represent mean and standard deviation, respectively. 5-Point Likert scale; 1–8 variables range from (1) "very good" to (5) "very bad" and 9 and 10 variables range from (1) "always" to (5) "never".
* Indicates $p < .05$.
** Indicates $p < .01$.

representation and recognition in decentralised energy production by underlying the female-to-male ratio statistics. By surveying and interviewing members of co-ops, we analysed the disproportional visibility of genders and how power relations are structured and reproduced. We explored intersecting patterns in multiple categories, such as gender and social class [95].

We triangulated all the data from the mixed-methods research design [96]. We analysed the sex ratio of energy co-op board members to test H1. The sample for EB consisted of N = 1012 individuals, and for SB members, N = 1367 people, which resulted in the female-to-male ratio analysis. To test the H2, we used two variables (Variables 3 and 9) from the online survey and reflected on these results in the interviews. H3 relates to Variables 1, 8 and 7 from the survey, which we further discussed in the interviews. We included three variables (Variables 10, 4 and 5) from the survey and reflections from the interviews to test H4. Similarly, H5 referred to Variables 2 and 6 from the survey and interview data.

Thematic analysis was used for the interviews to "identify, organise and offer insights into themes" within the data by generating a codebook [97]. Both descriptive and interpretative codes were created, categorised, and altered until all the themes were logical and meaningful to the respective hypothesis. Finally, we integrated a variety of perceptions into topics and themes introduced in our conceptual framework.

While this study was carried out using mixed-methodological tools and data, there are some limitations to disclose. It was challenging to encourage the co-ops to participate in an interview or distribute the online survey to their members about gender equality. As expected, our quantitative survey sample has biases with older, educated and male respondents. Regarding participation, some respondents left notes to the survey stating their relatively passive role as members, only attending annual meetings and voting for board members. Lastly, our methodology had limitations in having a deeper understanding of the management and leadership roles within a co-op, which we argue in the discussion.

4. Results

This section presents the findings from the sex ratio, online survey, and in-depth interviews in three sections corresponding to the conceptual framework. The α of the 5-point Likert scale variables of the gender equality questions in the survey was measured at 0.691, which estimates the reliability of the used scales.

4.1. Representation of genders in EB and SB

We included 388 co-ops in Germany in our sex ratio analysis. Table 2 shows the ratio of female to male board members from the energy co-ops in the respective German state.

Management of the renewable energy co-ops consists of two boards, and H1 argues that there are more men than women in these leadership roles. Our analysis included the sex ratio of SB members (N = 1367) and EB members (N = 1012) to verify H1. There could be a minimum of 1, a maximum of 20, and on average 3.5 members observed in SB; a minimum of 1, a maximum of 8 and on average 2.6 members observed in EB. The share of females in SB seats (14 %) is slightly higher than the number of females in EB (10 %). Regarding the number of males in

Table 2
Number of co-ops per 16 German States and their sex ratio of Executive and Supervisory Board members.

Federal states	Number of co-ops	Executive Board members		Supervisory Board members	
		Female ratio	Male ratio	Female ratio	Male ratio
Baden-Württemberg	149	8 %	92 %	14 %	86 %
Bavaria	60	9 %	91 %	11 %	89 %
Berlin	5	0 %	100 %	30 %	70 %
Brandenburg	12	20 %	80 %	24 %	76 %
Bremen	2	17 %	83 %	33 %	67 %
Hamburg	3	29 %	71 %	0 %	100 %
Hesse	22	11 %	89 %	10 %	90 %
Mecklenburg-Western Pomerania	8	20 %	80 %	21 %	79 %
Lower Saxony	25	11 %	89 %	13 %	87 %
North Rhine-Westphalia	26	9 %	91 %	28 %	72 %
Rhineland-Palatinate	28	10 %	90 %	13 %	87 %
Saarland	5	0 %	100 %	0 %	100 %
Saxony	12	16 %	84 %	9 %	91 %
Saxony-Anhalt	10	21 %	79 %	20 %	80 %
Schleswig-Holstein	6	25 %	75 %	22 %	78 %
Thuringia	15	6 %	94 %	4 %	96 %

management roles, they constitute the majority in both SB (86 %) and EB (90 %).

The data shows the underrepresentation of female members in the management of German co-ops. In some regions in Germany, the number of females in leadership positions is lower than in others (see Table 2). Thus, our findings support H1.

4.2. Women's active participation

Overall, 466 people opened the link to the online survey. The completed and valid cases that constitute the sample (N = 161) represent a response rate of 34.5 % (see Appendix), which is relatively high. Internet-based surveys tend to have lower response rates, with extended versions having as low as 12 % [98]. The number of men (68.9 %) was proportionately higher than women (30.4 %), along with one non-binary respondent. Most of the sample was over 55 (61.5 %), with 26.8 % between 35 and 54 years and 11.8 % between 25 and 34 years old. 72 % of the respondents had a university, college, or higher degree. Most respondents were either full-time employees (N = 65) or retired (N = 58). Similarly, over 80 % of respondents were in relationships (e.g., married, partnership), with only 11.8 % being single. Even though the socio-demographics of the respondents are not heterogeneous, the survey sample is representative of the energy co-ops in Germany, as educated, older men are known to be involved in more than other social groups [42,45].

H2 expected that members would evaluate women's participation in renewable energy co-ops to be low. We asked the survey respondents to select their role at the co-op with multiple-choice options. The majority of the respondents (N = 100) were active members of the co-op, whereas there were fewer SB members (N = 15) than EB members (N = 43). There were five employees and six respondents with other roles, such as a founding member of a co-op or board assistant. Over 60 % of the participants indicated that they had investments in their co-ops in the amount of 2000€ or more. From this, men respondents (42.3 %) had investments over 5000€, whereas women members' investments were >5000€ (28.6 %), 2000€–5000€ (22.4 %) and 200€–500€ (22.4 %). Additionally, 38.8 % of the women respondents declared an annual household income between 20.001€ and 50.000€ with ages ranging from 24 to 45 (36.8 %) and 55 years and older (41.1 %). Of these women, 15.7 % were single, and 73.6 % were married or living with partners. In contrast, the annual income of men was between 20.0001€ and 50.000€ (31.5 %) and 50.001€ and 80.000€ (31.5 %). The gender pay gap can partially explain the difference between the investment amounts [42]. Moreover, married couples in Germany have joint income taxation, which adds up the spouses' income, which might impact women's negotiation power to invest [40].

Women's participation variable was checked for its correlation with the opportunities variable ($p = .057$). When asked to assess the participation of women in their co-ops, most of the respondents (41 %) answered average, some rated good (23.6 %) and poor (20.5 %). More men respondents evaluated the participation of women slightly more poorly than women respondents. Furthermore, most respondents (67.1 %) believed that opportunities to invest in co-ops are always equal for women and men. Within that, more men (72.1 %) argued the opportunities to be always the same, whereas responses of women ranged between always (55.1 %), often (26.5 %) and sometimes (16.3 %).

Although the survey results evaluated the participation of women in energy co-ops as somewhat balanced, other variables and interviews discovered further insights. In seven interviews, participants estimated the number of women members in their co-ops to range between 30 % and 40 %. Even though the opportunities seem equal for all, other aspects like the gender pay gap and domestic responsibilities, like household workload, came into the discussion as underlying factors in the interviews. One respondent explains the different experiences of genders as follows:

> "We now have women entering these professions as accountants, businesswomen, and engineers. But the whole scene is still very much dominated by men in their 60s. These are mainly the pioneers who started the energy transition 20 or 30 years ago, either working in a company or starting a cooperative…As far as participation is concerned, there is complete equality. Any woman can become a member at any time, can participate just like anyone else, and any woman can run for office just as well. There are also no invisible limits for a board position or a supervisory board. It is, so to speak, a consequence of the overall context that no women were involved up to now."
>
> (Executive Board member, Man)

In terms of participation and investment opportunities, there are no technical burdens, but in practice, the share of women as members and co-op leaders is lower than that of men. Therefore, the results partially support H2.

4.3. Democratic and self-functioning co-ops

H3 expected the relationship between the boards and members to be working well. There tends to be a group identity within energy co-ops, with members having similar values and motivations towards the energy transition [20]. The most frequently answered option for how survey participants became aware of the involvement opportunity was through personal contact with the project and co-op initiators (30.4 %). Other answers were: attending public information events (24.2 %) and doing individual research on co-ops (19.9 %). For women respondents, personal contact with initiators (24.5 %) and recommendations from friends, family or neighbours (22.4 %) were selected as the most common options. Men, on the other hand, apart from their contact with initiators (32.4 %), found more opportunities at public information events (27 %).

Survey respondents selected contribution to the energy transition as the most frequent (85.1 %) motivation to be involved in a renewable energy co-op. The following frequent answers were to create dialogue and acceptance of technologies in a place (33.5 %) and co-op's democratic and participatory structure (30.4 %). Other motivations were the financial advantages of investments, bringing competition to the energy landscape, being independent of fossil fuels and creating regional added value. For men (31.5 %), the financial advantages of the co-op were a more critical motivation factor than for women respondents (16.3 %).

One interviewee defined *co-ops* as the most simple, democratic, and advantageous form of financial participation. Similarly to the quantitative findings, the qualitative data shows that taking individual and collective actions towards climate change are the main motivations. Other drivers were active involvement in the energy transition, having financial benefits from renewable energy production and contributing to the acceptance of technologies.

Over half of the respondents dedicate weekly hours to co-op activities, including working or volunteering. When asked if the indicated working time affected their domestic responsibilities (e.g. childcare, eldercare, house chores), men respondents mostly disagreed, whereas women respondents agreed with the statement. For the retired participants from the interviews, the workload of being a board member was easy to manage. For other interviewees that were employed and board members, balancing household responsibilities and volunteering tasks could become challenging at times. One interviewee reflected on the volunteer-based workload for women as follows:

> "Of course, our experience is that voluntary participation in a cooperative, in some cases, is more difficult for women. One example of this was the last constitution of our Executive Board, where a woman was approached to join the Board, and she was very keen to do so but then cancelled at short notice because she did not think she could do it with two children and her own business. (She) found out in the preliminary discussions that the meetings were held at

inconvenient times. 6 to 7 p.m., when dinner is served, and you go to bed, it is tough to reconcile that."

(Managing Director at a co-op, Man)

Experience variable showed a significant correlation with responsibilities ($p = .001$) and relationships ($p < .001$) variables. Survey participants were asked to rate their experience of being involved in a co-op, and most of the answers were either very good (47.2 %) or good (40.4 %). Furthermore, the distribution of responsibilities between the board and its members was evaluated well (47.2 %). The responses were mostly good (56.5 %) when asked about the relationship and connection between the co-op board and its members. Triangulation of the survey and interview data, therefore, supports H3.

4.4. Obstacles for women

We hypothesised that women face more obstacles or gender barriers than men members within co-ops (H4) and that the co-ops' consideration and awareness of women's needs and diversity would be evaluated low (H5). The barriers variable was negatively correlated with awareness ($p = .003$) and consideration ($p < .001$) variables. Survey participants estimated to what extent women in search of opportunities or involved within co-ops would face gender barriers. The answers were equally circulated between rarely (33.5 %) and never (33.5 %), followed by sometimes (21.7 %). For women respondents, the possibility of encountering barriers was rare (34.7 %), followed by sometimes (28.6 %). Whereas for men members, the most frequent answer was never (38.7 %), followed by rarely (33.3 %).

Participants rated the co-op's awareness of family and personal living conditions to be good in the overall sample (48.4 %), whereas women's answers were primarily average (44.9 %). When asked to rate the co-op's consideration of women's strategic and practical needs, the answers were mainly average (39.1 %). Answers from women respondents were mostly piled up on the co-ops' consideration to be average (49 %), whereas more men evaluated it to be good (42.3 %).

Concerning H5, we asked the participants to rate the openness of co-ops to potential members and the opportunities. The responses mostly ranged between very good (45.3 %) and good (44.1 %). Lastly, measurements of co-ops to ensure diversity and inclusion for all groups were rated mostly average (43.5 %) by all participants. There were no significant differences between the answers of women and men participants.

Survey respondents selected three barriers for women that would hinder their participation in an energy co-op: lack of awareness of opportunities (N = 73), lack of financial resources (N = 70), and the technicality of the projects being a determinant (N = 67). Responses that followed were lack of time, lack of gender targets in co-ops, complex political framework of co-ops, no obstacles, and lack of attractiveness for women.

During the interviews, all the board members highlighted the co-ops to be open and accessible to all. However, they considered that co-ops should be more attractive for women than other participation opportunities within the energy transition. It has a democratic structure, but it does not address the limitations of specific groups as they are trying to survive as companies. A man respondent emphasised that "it is, unfortunately, the case that *women are difficult to find or inspire*". However, respondents also mentioned that women have fewer financial resources and time to be involved in co-ops. Additionally, stereotyping of women as not fitting to technical areas, lack of women representation in localised energy production and gender equality on the policy level were discussed as hindrances for women.

In line with the findings from the survey and interviews, obstacles for women are more common than for men. However, the analysis allows us only partially to verify H4. Even though co-ops are open for potential members, as H5 argues, diversity or inclusion for all social groups is not mainly addressed.

4.5. Suggestions and measures to diversify co-ops

Survey respondents selected 3 of 6 provided measurements to increase the number of women in energy co-ops and the option to write one themselves. The most frequent answers were holding information and discussion events for women, networking, sensibility and awareness campaigns on gender and diversity. For women respondents, it was also essential to have *equal and flexible working/volunteering tasks* and have *knowledge exchange between women in leadership roles*.

During the interviews, one of the leading suggestions to overcome gender barriers was to have promotional programs. Some of the co-ops we interviewed applied for these programs to address gender issues and encourage a diverse group of people to be involved in their organisation. Workshops for women to introduce the co-op structure, training for all genders to recognise inequalities and support women's empowerment by training them for leadership roles were suggested as measures.

Improvement of the communication strategies was highlighted in the interviews as well. Developing the technical language and outdated websites of co-ops could appear more attractive to a broader audience. In one of the interviews, this was emphasised:

"We try to have a gender gap communication to focus on male and female members, to show the diversity of our membership and all the tools. We are very interested in having members of all ages, all backgrounds, all ethnicities, and an intersectional approach. Especially people with a migrant background. But it is not easy. Measures might be tried to address to prepare the material and the information in a language which is understandable for all people. Communication is a big topic."

(Executive Board Member at a co-op, Woman)

Even though this paper focuses on women, we asked the survey respondents to select other social groups they see as underrepresented. Low-income groups were the most frequent answer (N = 89), followed by immigrant background groups (N = 75) and younger people (N = 72). Similarly, the interviews highlighted younger people and people with limited financial resources as underrepresented groups. However, some respondents argued that this tendency is related to taking over responsibility and becoming a shareholder or a member rather than having the resources to do so.

Setting a low share limit to participate and invest in a co-op and having more national co-ops instead of only local ones could encourage a more diverse group of members. Additionally, grandparents buying shares in a co-op for their grandkids could inspire younger generations to be involved in the energy transition.

5. Discussion

Renewable energy co-ops in Germany play an essential role in contributing to decentralised energy production and the energy transition. Due to their social structure, co-ops have the potential to reflect the dynamics of public participation [24]. This study further investigated the recognition aspect of justice within co-ops and explored the different implications for genders. We will discuss the implications of the findings in this section.

Renewable energy co-ops in Germany seem to be managed and occupied mostly by men, which is also found by other studies [20,42,99]. Survey results indicated a significantly higher number of investments from men, which also relates to the indicated income of men being higher than women. However, gender injustices were not recognised strongly by the management of the co-ops, and there was a strong emphasis on the co-ops being open to any interested person [50]. The gender pay gap explains one crucial aspect of our findings: involvement within co-ops requires financial resources [42,46]. A lower-threshold offer and sharing the investments with other individuals for membership would create fewer financial risks. It could also overcome the concerns over the complete layperson of an

investment. It would also be helpful to keep the minimum financial investment low enough to diversify the participation, Wierling et al. suggest [70].

We found expectations of the financial profits of co-ops to be important motivations, similar to other studies [49,100]. Likewise, literature shows that the motivations of men and women in their involvement in local energy initiatives tend to differ [64,77,101]. Our results showed that men selected financial benefits from the co-ops as a significantly more motivating factor than women. For women, contribution to the energy transition was the most significant driver, followed by the co-ops' democratic and participatory structure. Women's cultural and socio-ecological framings about their environment tend to differ from men's macro-political framing of energy issues, as Yaka suggests, which might impact their motivations [58]. These align with the studies that argue climate protection for future generations is affiliated more with women's involvement in environmental movements [99,102].

In contrast, ecofeminism critically examines the women-nature-femininity nexus that constructed gendered, racial and ecological inequalities and exclusion worldwide [43]. Women's active and meaningful participation in renewable energy production seems limited. Hegemonic masculinity tends to dominate the political discourse under eco-modern goals by favouring existing solutions rather than demanding systematic change [103]. Our results also show that participation and leadership motives are more vital for men than women [77,99].

Previous studies argue that the volunteer-based workload of co-ops could be one barrier for women [42,64]. However, some studies suggest that women tend to take on volunteering activities more than men [66]. Our results show that women who allocate weekly hours for their co-op activities agree with its negative impact on their household workload. This impact relates to social norms of the gendered division of domestic labour that might affect women's ability to volunteer [46,104]. Therefore, realising the different needs of genders, allowing flexibility for co-op tasks and planning activities in times that fits a broader group, rather than retired or unemployed people, would potentially support the involvement of women. Additionally, offering women employment and pay to manage a co-op could be another solution [45,64].

Our findings highlight that women and men are informed about opportunities differently. Most men respondents suggested that women were not interested in taking on responsibilities in energy co-ops. Energy technologies are scripted as masculine, which could also limit women's engagement enforced by gender norms (e.g. [54]). We further argue that men categorising women as *uninspired* (Executive Board member at a co-op, Man) is a barrier and feeds into the stereotyping of women. Unless the potential members have a direct connection to project initiators, recommendations from their social surroundings are essential drivers for women's involvement in energy co-ops. Members' social networks may also play a role in which genders are invited or encouraged to join the co-op boards.

Studies argue that technical knowledge of energy systems plays a vital role in the management of co-ops [19]. Contrary to this precondition, our findings highlight the importance of *learning-by-doing* for leadership rather than special technical training or skill sets. Leadership is key to facilitating the co-op model [15]. Our findings support the recommendation to create a mentorship program for women to exchange experiences, ideas, and competencies as a subsidiary co-op model. A network for women involved and interested in finding opportunities in energy co-ops around Germany could support that [46].

The needs of women concerning energy issues are reflected differently in Germany than in the Global South, where the practical, productive, and strategic needs of women are changing and need further attention [28]. The needs of women differ within the intersections of their social class, age and racial ethnicity as well. Our findings and literature show that renewable energy co-ops should address the inequalities and create awareness, knowledge and expertise to overcome disparities [105]. Programs to discuss ways of including women in co-ops propose an opportunity for active learning, brainstorming and encouragement for a more heterogeneous group to be involved. However, most co-op members work on a volunteer basis, and their time, opportunities, and resources are limited as they are dependent merely on their members' equity and investments, similarly to Bauwens et al. suggest [49]. Market-independent support mechanisms through a government program would help overcome these limitations.

Lastly, women are not the only underrepresented group in co-ops. Our analysis focused on women, although we also examined intersections of vulnerable groups. We identified low-income groups as the most prominent underrepresented group in energy co-ops, which supports previous findings showing that mostly middle-class benefits from co-ops [20,24]. Some social groups experience multiple underrepresentation in energy co-ops simultaneously due to their income, racial ethnicity and gender. Furthermore, focusing on other intersections of marginalised groups, such as Black people and people of colour, may yield further inequalities that we did not investigate in the scope of this study. One aspect that could be improved is the image of the co-ops, as it might be intimidating for some social groups to get involved in a structure that could be called an *old boys club* (see also [8]). The co-ops should try lighter language in their advertisements, which would be more understandable for people outside the industry or technical areas.

Our results show the encouragement to have younger generations involved in the energy transition and co-ops. According to our findings, buying co-op shares as membership gifts for younger people is one practical aspect. Communication and advertisement tools like being present in local events (e.g., Fridays for Futures demonstrations, stands in local markets, ads on bike sharing apps), could target a wider interest group for co-ops. Some co-ops have websites to inform their communities, but communication through social media platforms and town websites can increase visibility. However, the financial resources of individuals could still be a limitation to participating. Co-op activities can become a burden for board members that have full-time jobs. Creating employment or internship opportunities through government-supported co-op programs could be an alternative solution to attract the youth and support co-op board members.

Future research could investigate renewable energy co-ops as in-depth case studies and examine what type of leadership the board members have and whether this differentiates between genders. It would be valuable to observe women's leadership in a male-dominated environment and whether they act according to the institutionalised masculine norms like Magnusdottir and Kronsell suggest [82]. One suggestion from the literature (see [106]) could be to organise a focus group discussion at a convenient time for women while allowing them to bring young children to the meeting. It might overcome some recruiting and methodological issues in this study (see [106]).

Another factor that could be further examined is the urban-rural contrast and whether co-ops in bigger cities with more members tend to attract a diverse group. This study indicates overall results for German energy co-ops, but we realise the cultural and socio-economic differences between regions. The generalisability of the study results is conditional on the different characteristics of the co-ops (e.g., amount of members and type of project investments). Future research could explore gender nuances in co-ops comparatively and examine place-based influences. With such research efforts, the socio-cultural and institutional barriers for women could become visible, and we could take one more step towards a more inclusive energy transition.

6. Conclusions

This study aims to reveal social inequalities in women's participation, involvement and leadership in local German energy initiatives. We use gender and justice as analytical categories to investigate a local engagement structure: cooperatives. Our findings highlight the statistical dominance of male members in energy co-ops. Rather than only reporting on the quantitative gender-related differences, we further

deepen the knowledge about the sensibility of power relations and social inequalities with the intersections of socio-cultural identities.

The results of this study show that women are underrepresented in the management and leadership roles in renewable energy co-ops around Germany. Factors like lack of awareness of opportunities, time, and the gender pay gap impact this imbalance. Moreover, the results argue that women are stereotyped as uninspired and unwilling to take on the leading role without considering the existing gendered social context within co-ops. Umbrella co-op organisations (e.g., national and federal state-level associations) could have programs to spotlight woman board members and create visibility for the gender imbalance in co-ops. Women's leadership and participation encourage other women to join through better communication strategies. Language and pictures on the co-op's website and flyers could be improved and diversified. Another solution could be to create support programs through government schemes that would include mentoring for women involved in co-ops and those interested in joining. Moreover, other social groups (e.g., immigrant and low-income groups) could also benefit from recognising these intersections of social class, ethnicity and age. By applying an intersectional approach, the social distribution of benefits from co-ops should be accessible to a broader social group.

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CRediT authorship contribution statement

Irmak Karakislak: Conceptualization, Project administration, Methodology, Formal analysis, Investigation, Supervision, Writing – original draft, Writing – review & editing. **Pantea Sadat-Razavi:** Software, Formal analysis, Writing – review & editing. **Petra Schweizer-Ries:** Supervision, 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.

Data availability

Data will be made available on request.

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Appendix A

Table A
Socio-demographics of the survey sample.

Age	Percentage
18–24	–
25–34	11.8 %
35–44	7.5 %
45–54	19.3 %
55–64	28.0 %
65 and older	33.5 %
Education	
No formal education	–
Primary/secondary school degree	3.1 %
Middle school degree	4.3 %
High school degree	3.1 %
Training degree	15.5 %
College degree	21.7 %
Bachelor degree	33.5 %
Master degree	8.1 %
Doctoral degree	8.7 %
No indication	1.9 %
Annual household income	
Under 20,000€	5.0 %
20,001€–50,000€	33.5 %
50,001€–80,000€	28.6 %
80,001€–110,000€	11.8 %
110,001€–150,000€	8.1 %
150,001€ and more	2.5 %
No indication	10.6 %
Federal state	
Baden-Württemberg	9.3 %
Bavaria	6.2 %
Berlin	5 %
Brandenburg	1.2 %
Bremen	1.9 %
Hamburg	1.2 %
Hesse	5.6 %
Mecklenburg-Western Pomerania	1.2 %
Lower Saxony	2.5 %
North Rhine-Westphalia	3.7 %
Rhineland-Palatinate	8.1
Saarland	49.1 %

(*continued on next page*)

Table A (*continued*)

Age	Percentage
Saxony	0.6
Saxony-Anhalt	–
Schleswig-Holstein	1.2 %
Thuringia	3.1 %

N = 161.

Table B
Information on the interviewees.

	Role at the co-op	Gender	Occupation
1	SB	Male	Retired/administration
2	EB	Male	Retired/information technology
3	EB	Male	Engineer
4	EB	Male	Retired/teaching
5	EB	Male	Retired/finance
6	EB	Male	Managing director at co-op
7	SB	Female	Energy project developer
8	EB	Female	Coordinator at NGO
9	Membership in multiple co-ops	Male	Head of renewable energy department

N = 9.

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.erss.2023.102947.

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