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# Who wants to get involved? Determinants of citizens' willingness to participate in German renewable energy cooperatives

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## Abstract

This paper analyzes the potential for citizen participation in renewable energy cooperatives and in the energy transition process. We consider representative survey data for more than 4,200 financial decision-makers in German households and analyze (i) differences between members and non-members of renewable energy cooperatives, (ii) non-members' willingness to participate in energy cooperatives, and (iii) factors determining citizen participation in terms of not only voluntary involvement, but also private investments. We find that the lack of familiarity with energy cooperatives among non-members is a limiting factor for the expansion of citizen participation, a finding that indicates the potential of information campaigns. However, we also reveal a substantial participation potential, as about 40% of the non-members who are familiar with the term "energy cooperative" express a high willingness to become involved. Our econometric analysis based on bivariate binary probit models complements the current state of research by showing the relevance of economic preferences such as time preferences, trust, and negative reciprocity. Interestingly, psychological personality traits, measured by the Big Five, are found to be of minor importance. We additionally confirm the findings of earlier work with regard to the relevance of individual environmental values, social contextual factors, and social norms.

*Keywords:* Citizen participation, community renewable energy, energy transition, Big Five personality traits, economic preferences, social norms

*JEL classification:* G11, M14, Q01, Q 49, Q56

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## 1. Introduction

There is broad consensus among both academics and policy-makers concerning the necessity of a system-wide transformation to achieve a low-carbon economy based on the efficient use of renewable energies. The achievement of the corresponding international and national goals requires both the mobilization of private investors and the political approval of the necessary legislative reforms by citizens.

Community renewable energy projects and energy cooperatives in particular are seen as promising instruments, as they allow both citizens' financial participation [1,2] and civic engagement [3,4]. In addition to other positive effects, such as the empowerment of citizens in the energy sector [5], or the potential to secure funding for small-scale decentralized projects that are not appealing to large investors [6], the involvement of citizens seems to promote acceptance of renewable energy projects [7,8]. Since the development of energy cooperatives depends crucially on volunteerism and the mobilization of private investments, it is important to identify the determinants of citizens' participation. However, the majority of quantitative research in this field has focused on the perspective of members of cooperatives [1,9,10] as opposed to that of non-members as a target group for initiatives intended to increase citizen participation in the energy transition.

Therefore, this paper follows Kalkbrenner and Roosen [11] and analyzes the determinants of citizens' intentions to volunteer as well as to invest. In contrast to previous studies, we consider a group of citizens with a particularly significant potential to contribute, namely financial decision-makers in households who already have made some investment experience. Thereby, we seek to address the following research questions:

- To what extent do the characteristics of members and non-members of energy cooperatives differ from each other?
- How large is the proportion of financial decision-makers in households who are willing to participate in an energy cooperative?
- Which factors determine participation intentions?
- What can we learn in terms of developing this potential in order to achieve climate targets?

We analyze data from a representative survey among 4,210 financial decision-makers in German households carried out in two waves during 2019. Based on the framework

developed by Stern [12], we consider a wide range of potential determinants of participation, that is, attitudinal factors comprising perceived costs and benefits, personal norms and beliefs as well as economic preferences, personal capabilities proxied by individual personality traits, financial literacy, and socio-demographic characteristics, and contextual factors such as social norms. We first identify members and non-members of energy cooperatives. This allows us to compare the characteristics of members of these groups and to quantify the share of non-members who are willing to participate in energy cooperatives. Second, based on estimates of bivariate binary probit models, we analyze the relevance of various potential determinants to a high willingness to volunteer and to invest in energy cooperatives.

Our analysis reveals that only 1.76% of the respondents are already members of energy cooperatives, and only about 38% of the financial decision-makers are familiar with the term “energy cooperative.” Within the latter group, our data show a substantial share of respondents indicating a high willingness to volunteer (36%) or invest (43%) in energy cooperatives, thus confirming the findings of previous studies [11,13,14]. Comparing the group of members and non-members, we find that the group of members comprises younger persons, a lower share of women, and higher shares of highly educated as well as high-income persons on average. Notably, these factors seem to play only a minor role in determining the willingness to participate in energy cooperatives among non-members. Based on our multiple regression analysis, we only find significant correlations for gender and household net income, whereas regional factors (i.e., whether a respondent stems from a rural area or from a West German federal state) have no significant impact. Instead, our findings underline the importance of attitudinal variables (e.g., ecological political identification), perceived costs and benefits (e.g., warm glow, but also return expectations), social norms and additional contextual factors, such as social signaling motives, perceived expectations of the social environment, and prior volunteering experiences. Regarding economic preferences, three patterns emerged: First, patient individuals are more likely to have high participation intentions towards energy cooperatives. Second, high levels of trust are positively associated with the intention to invest. Third, we find a strong and stable positive relationship between negative reciprocity and both forms of participation. Finally, personality traits are only weakly related to the probability of indicating intention to participate.

This paper contributes to various fields of research. First, we contribute to empirical research on the determinants of citizens’ participation in energy cooperatives [9,13] and community renewable energy [15]. To the best of our knowledge, this is the first study in this context to simultaneously considering the full set of economic preferences (i.e., risk aver-

sion, patience, and social preferences) according to Falk et al. [16], personality traits [17], and financial literacy [18]. As a consequence, we also provide further empirical evidence of the importance of economic preferences [16,19], personality traits [20], and their interdependence [21]. Third, as participating in an energy cooperative is one possible form of socially responsible investment (SRI), we also contribute to the more general field of SRI [22,23], as well as volunteerism research [24].

The remainder of the paper is structured as follows: In Section 2, we discuss the theoretical framework of our empirical analysis and the related literature. In Section 3, we describe data, variables, and methods. In Section 4, we describe the results from descriptive statistics and estimations, and, finally, we draw conclusions in Section 5.

## 2. Literature review

### 2.1. Community renewable energy and energy cooperatives

Community renewable energy refers to a variety of organizational forms for the establishment and operation of decentralized renewable energy projects [10,25,26]. It is considered a characteristic of community renewable energy that projects are implemented in a way that involves the local population on a process dimension and that results in a collective benefit for the local community on an outcome dimension [26]. In this framework, (renewable) energy cooperatives represent an ideal example. On the process dimension, cooperatives offer a participatory framework in the form of their democratic principle of “one member, one vote,” the concept of limited liability, and low financial entry barriers. To become a member, people need to purchase shares in a cooperative by making a low minimum investment. On the outcome dimension, cooperatives are explicitly linked to the promotion of their members’ goals [10]. As of 2020, the European federation of renewable energy cooperatives REScoop has registered more than 1,500 energy cooperatives with around 1 million members.<sup>1</sup> Scholarly attention has focused in particular on energy cooperatives in Germany [2,10,27,28] and Belgium [1,9,29]. Furthermore, the development of energy cooperatives has been documented in Austria, Denmark, the United Kingdom [30], France, and Sweden [31]. In Germany, energy cooperatives are the predominant organizational form of community renewable energy projects [32]. In 2015, more than 180,000 members belonged to 901 energy cooperatives, which accounted for 1.3 billion euros in tangible assets [33]. The vast majority of German energy cooperatives are very small companies whose managers work on

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<sup>1</sup> Source: <https://www.rescoop.eu>, 2020 (accessed January 15 2020).

a voluntary basis [27]. Thus, both volunteering and financial participation of citizens are crucial for the successful development of energy cooperatives.

## *2.2. Determinants of participation in energy cooperatives*

Our study builds on the theoretical framework of environmentally behavior developed by Stern [12], who conceptualizes behavior as an interactive result of individual attitudinal factors, personal capabilities, and contextual factors. We derive potential determinants covering various aspects of these factors from previous empirical studies in the field of community renewable energy [9,11,13,34,35], as well as from the fields of individual SRI [22,23,36] and volunteerism [24,37]. Previous studies on investment and participation intentions have focused on determinants that are closely related to community renewable energy. For example, Kalkbrenner and Roosen [11], as well as Koirala et al. [13], investigated the role of community identity, community trust, energy related social norms, and the private ownership of renewable energy technologies. In contrast, Ebers Broughel and Hampl [34] put more emphasis on the significance of attitudes towards renewable energies. Complementing these studies, the present investigation is inspired by insights provided by behavioral economics and empirical economic research. We assume that the willingness to participate depends on not only the individual political orientation [22,38,39], and preferences towards risk, time, altruism, and reciprocity [16], but also on perceived non-pecuniary benefits, in terms of feelings of warm glow [40], individual capabilities, such as psychological personality traits [37,41] and financial literacy [18].

### *2.2.1. Personal attitudes*

Following Stern [12], we summarize all factors that relate to subjective dispositions, such as personal norms, convictions, and beliefs including perceived costs and benefits of a particular behavior, as personal attitudes. Kahnemann et al. [42] note that, at the core of an attitude, there is a valuation: “objects of attitudes include anything that people can like or dislike, wish to protect or to harm, want to acquire or to reject.” In short, personal attitudes provide information as to what people want. In this respect, research on the individual intention to participate in community renewable energy has already shed light on the relevance of (community) trust [11,13] and pro-environmental concern [11,13], as well as of the perceived riskiness of investing in such projects [34,35]. The importance of individual trust, environmental values, and perception towards returns and risk has also already been revealed in the context of individual SRI [23,36,43,44]. Nonetheless, individual attitude towards trust is only one component of individual economic preferences that is relevant

to a variety of economic outcomes. Other aspects include attitudes towards risk, time, altruism, and reciprocity [16]. For example, altruism and trust are significantly related to the probability of volunteering one's time, whereas negative reciprocity is significantly correlated to a person choosing to voice his or her opinion to a public official [16]. Given this evidence and the fact that these factors have thus far not been prominently discussed in volunteerism research [24,45,46], it appears reasonable to include them in our analysis. Additionally, their inclusion should mitigate potential omitted variable bias, as the different facets of economic preferences are typically correlated with each other [16]. Finally, studies in the field of individual SRI additionally reveal the relevance of individual ecologically oriented political identification [36] and particularly the perceived psychological benefits in terms of feelings of warm glow [40] from sustainable behavior. Accordingly, we also consider these factors in our analysis.

### *2.2.2. Personal capabilities*

In line with Stern [12], we define personal capabilities as material and non-material resources, skills, and knowledge. All of these factors determine a person's scope of action and provide information about what he or she is able to do. We consider socio-demographic characteristics as proxies for personal capabilities [12]. Referring to energy cooperatives, the largest survey of members of German energy cooperatives with about 2,800 respondents, has shown that 54% of the respondents were between 45 and 64 years old, 80% were male, 57% held a university degree, 49% had a monthly gross income of more than 3,500 euros, and 80% were members of a civil society organization [47]. Thus, membership seems to be particularly attractive to male, middle-aged, and well-educated people with comfortable incomes. In line with these findings, Masson et al. [14] identified gender, education, and income as predictors for the willingness of non-members to participate in an energy cooperative. Furthermore, prior participation in an environmental organization correlates positively with participation intentions [14]. This picture corresponds to the findings of volunteerism research, such as the tendency of men and women to volunteer at different rates, at different hours, and in different domains; highly educated people usually belong to several volunteering organizations; and low-income earners volunteer less frequently [24]. In contrast, based on survey data for Dutch citizens, Koirala et al. [13] only statistically confirmed the significance of education in general and energy-related education in particular but found no evidence supporting the relevance of age, gender, or income for participation intentions in community renewable energy.

Our approach is generally in line with research on individual financial behavior showing that a holistic approach that jointly includes several facets of capabilities, such as individual financial literacy and personality traits, more adequately explains individual savings behavior than approaches that only consider a few potential factors [48]. In this regard, individual financial literacy is one potential key factor for financial participation in energy cooperatives, as it is often crucially related to individual economic and financial decision-making [49]. However, previous empirical studies on individual investments in renewable energies or community energy projects have neglected this factor so far. In contrast, several studies on individual SRI consider self-assessed investment knowledge as a potential determinant [23,50,51,52], but there is no clear tendency with regard to the statistical significance or direction of the effects. Thus, whether financial literacy is related to participation in energy cooperatives remains an open empirical question, and we have no clear expectations with regard to a positive or negative relationship.

We additionally consider personality traits, which are defined as “[. . .] relatively enduring patterns of thoughts, feelings, and behaviors that reflect the tendency to respond in certain ways under certain circumstances.” [53]. The most commonly used framework for personality traits is the Big Five framework [17], which captures the traits of openness to experiences, conscientiousness, extraversion, agreeableness, and emotional stability. Prior research has shown that personality traits are related to a variety of economic outcomes [17,21,54] and particularly individual financial behavior [48,55]. A number of studies in volunteerism research have also linked personality traits to volunteerism [24] and environmental engagement [41]. There is a consensus that personality traits play a role in volunteering decisions; however, the links between traits and different forms of volunteering seem unclear. For example, Wilson [24] reported that extraversion and agreeableness are most often associated with volunteering. In contrast, Bekkers [37] found that emotional stability is positively related to a high willingness to engage in volunteering, whereas Milfont and Sibley [41] concluded that agreeableness, conscientiousness, and openness to experiences are the traits that are most strongly linked to environmental engagement.

### *2.2.3. Contextual factors*

While attitudes and capabilities relate to personal factors, contextual factors include interpersonal norms, legal and institutional determinants, and factual monetary incentives and costs [12]. In particular, within the context of community renewable energy, social norms and (perceived) social expectations, as well as spatial context have been examined with regard to participation intention. Kalkbrenner and Roosen [11] showed that energy-

related social norms in terms of expectations and behaviors of peers have the highest impact on willingness to participate. Gutsche et al. [36] and Riedl and Smeets [23] have obtained similar results in the case of individual SRI, and Wilson [24] reported much the same for volunteerism. By way of example, Riedl and Smeets [23] show that the desire to create a positive self-image via signaling (i.e., social signaling) can be a driver for individual SRI. Similarly, Schwirplies and Ziegler [56] found that the desire to set good example for others is positively related to climate protection activities. Besides norms related to an individual's direct social environment, some studies also consider the role of broader geographical factors. For Germany, Masson et al. [14] determined a lower willingness to participate in energy cooperatives for people living in the east of Germany, which they trace back to prior experiences with cooperatives in the socialist economy of the former GDR. With regard to spatial patterns, Ebers Broughel and Hampl [34] identified a noteworthy segment of urban investors suggesting that place of residence influences investment decisions.

### **3. Data, variables, and methods**

#### *3.1. Data*

The data for our analysis stem from two representative online surveys (in terms of age, gender, and place of residence) among financial-decision makers in German households who are familiar with investment activities. The two surveys, which respectively had 1,710 and 2,500 respondents, were carried out in cooperation with the professional market research institute Psyma+Consultic GmbH (Psyma) in July and August 2019 and in September and October 2019, respectively.

We define the target group in line with Gutsche and Ziegler [22], who considered individuals who were at least 18 years of age, mainly or equally responsible for financial decisions of the household, and familiar with investment activities. The last criterion is satisfied by only including those decision-makers who (i) are currently invested in, (ii) had invested in, or (iii) have extensively informed themselves about stocks, equity funds, bonds, bond funds, or other investment products with flexible returns (such as options, certificates, open real estate funds, closed-end funds, or mixed funds). We thus consider a group of citizens that is of high importance in terms of funding the transmission process (via investments in renewable energies and is thus worth mobilizing).

The respondents were recruited from online panels by Psyma, which was responsible for the programming of the questionnaire, hosting the surveys, and, in particular, the recruitment process. To derive samples that are representative for financial decision-makers in

German households and not for German citizens in general, the recruitment procedure was split into two steps.<sup>2</sup> First, Psyma recruited people according to quotas for age, gender, and place of residence at the federal state level for the general German population. In the second step, we asked screening question concerning the respondents’ responsibility for financial decisions in their respective households and their previous investment experience. Only those who fulfilled the aforementioned requirements were allowed to proceed with the questionnaire. Furthermore, Psyma conducted quality checks (e.g., regarding systematic response patterns) on all completed questionnaires throughout the period in which the surveys were administered. Low-quality interviews were excluded from the samples, and new respondents were recruited accordingly. As discussed below, the characteristics of both samples are very similar, which allowed us to merge the two datasets for our empirical analyses. We additionally matched our data with the latest version of the German municipality directory [57], which enabled us to identify whether a respondent lives in a thinly or densely populated region.

### *3.2. Dependent and explanatory variables*

#### *3.2.1. Dependent variables*

Following Kalkbrenner and Roosen [11], we measure the respondents’ individual willingness to participate in energy cooperatives based on two questions. We first asked the respondents to indicate their willingness to volunteer during their leisure time in a regional energy cooperative that undertakes projects for renewable energies. Second, we asked whether the respondents would be willing to participate financially by making an investment in a regional energy cooperative focused on renewable energies. In both cases, we used a symmetric ordered response scale with the categories “very low,” “rather low,” “neither low nor high,” “rather high,” “very high,” and “don’t know.” On this basis, we constructed the two main dependent variables for our econometric analysis. The dummy variable “high willingness to volunteer” takes the value one if a respondent indicated a rather or very high willingness to volunteer in a renewable energy cooperative. In the same vein, the dummy variable “high willingness to invest” takes the value one if a respondent indicated a rather or very high willingness to invest in a renewable energy cooperative.<sup>3</sup>

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<sup>2</sup> Thus, for our samples, we expected a larger share of male, highly educated, and high-income persons compared to the general German population.

<sup>3</sup> For robustness checks, we additionally constructed two ordered variables that take the values one for “very low,” two for “rather low,” three for “neither low nor high,” four for “rather high,” and five for “very high,” respectively.

### 3.2.2. Explanatory variables

We build on questions from previous studies to capture the attitudinal, capability, and contextual factors discussed above. Table A.1 in the Appendix presents a detailed overview of the definitions and constructions of all explanatory variables.

We control for the socio-demographic characteristics by constructing the variables “age,” “female,” “high education,” and “HH net income above median class.” While “age” measures the respondents’ age in years, the dummy variable “female” takes the value one if the respondent is a woman. The dummy variable “high education” takes the value one if the respondent’s highest level of education is at least an advanced technical college certificate or a high school diploma. The dummy variable “HH net income above median class” takes the value one if the respondent’s household net income is above the median class and thus amounts to 3,000€ or more. Additionally, we capture further geographic factors by constructing the variables “rural region,” and “Western Germany.” With respect to the dummy variable “rural region,” we follow Ebers Broughel and Hampl [34]: This variable takes the value one if the respondent lives in a thinly populated municipality according to the German municipality directory [57], whereas the dummy variable “Western Germany” takes the value one if the respondent’s main residence is in one of the West German federal states (excluding Berlin) [36].

Feelings of warm glow, the first attitudinal variable, are captured by the dummy variable “warm glow,” which takes the value one if the respondent agreed with the statement “It makes me feel good to act sustainably.” Similar items have been previously used to identify determinants of individual clean consumption activities [58], SRI [22], or support for the German energy transition process [59]. As in the case of the dependent variables, we again used a symmetric scale with the five ordered response categories “totally disagree,” “rather disagree,” “undecided,” “rather agree,” and “totally agree.” This, or similar scales with five ordered response categories, was used throughout the questionnaire. If not stated otherwise, the corresponding dummy variables take the value one if the respondent selected one of the two highest response categories (e.g., rather or totally agree or rather or very high).

We capture individual pro-environmental orientation by means of the widely used New Environmental Paradigm (NEP) scale [60]. Instead of using the original scale, which has 15 items [11][16], we follow Whitmarsh [61], who found that respondents had difficulties interpreting 9 of the 15 items. The resulting six-item NEP scale has been applied in a variety of studies on energy and climate change-related topics [38,39,56]. To construct this measure, the respondents were asked to indicate to what extent they agreed with six statements. On

this basis, we constructed one dummy variable for each statement. The variable “NEP” is the sum of these six dummy variables and consequently ranges between zero and six.

Following Ziegler [38,39], we measure the respondents’ individual political identification by using four dummy variables “conservative political identification,” “liberal political identification,” “social political identification,” and “ecological political identification.” For example, the variable “conservative political identification” takes the value one if the respondent agreed with the statement “I identify myself with conservatively oriented politics.” The other three variables are constructed accordingly. In contrast to the use of simpler measures for political orientation (e.g., right-/left-wing indicators), this operationalization allows to draw a more differentiated picture of the impact of political orientation [38].

We measure perceived benefits and costs of participation using two dummy variables, which are constructed following previous studies in the field of individual SRI [23,36]. The variable “perceived higher returns SRI” takes the value one if the respondent perceived the returns of sustainable equity funds to be higher than the returns of conventional equity funds. In the same vein, the variable “perceived higher risk SRI” takes the value one if the respondent agreed with the statement “Sustainable equity funds are riskier than conventional equity funds.”

Our variables for risk, time, and social preferences are also based on several qualitative measures. In line with the approaches adopted by, for example, Dohmen et al. [62] or Falk et al. [16], the dummy variable “risk taking” takes the value one if the respondent indicated to be willing to take risks in general. Time preferences are captured by the dummy variable “patience,” which takes the value one if the respondent indicated a willingness to give up something that is beneficial for them today in order to benefit more from it in the future [16]. Social preferences are measured through the variables “altruism,” “trust,” “positive reciprocity,” and “negative reciprocity.” The dummy variable “altruism” takes the value one if the respondent indicated a willingness to give to good causes without expecting anything in return [16]. Our measure for trust is based on three items adapted from Dohmen et al. [19]. To this end, the respondents were asked to indicate to what extent they agreed with the following three statements: “In general, one can trust people,” “These days you cannot rely on anybody else,” and “When dealing with strangers, it is better to be careful before you trust them.” We constructed one dummy variable for each statement. The first dummy variable takes the value one if the respondent rather or totally agreed with the first statement, while the other two dummy variables take the value one if the respondent rather or totally disagreed with the latter two statements. The variable “trust” is the sum of these

three dummy variables and ranges between zero and three. The measures for positive and negative reciprocity are similarly constructed based on three items for each variable. The items were taken from Dohmen et al. [63] and are presented in Table A.1 in the Appendix. The two resulting variables “positive reciprocity” and “negative reciprocity” are again the sum of the three corresponding dummy variables and thus range between zero and three.

We use the Ten-Item Personality Inventory (TIPI) introduced by Gosling et al. [64] to capture the Big Five personality traits (i.e., openness to experience, conscientiousness, extraversion, agreeableness, and emotional stability). While this scale does not allow for different underlying facets to be measured in detail, its brevity is very appealing for online questionnaires, and it has been applied in several economically and environmentally relevant fields [41,65]. Accordingly, we presented two pairs for each of the Big Five traits to the respondents and asked them to indicate how strongly each pair applies to them. For example, the pairs “extraverted, enthusiastic” and “reserved, quiet” are used to capture extraversion with the first pair being the standard item and the latter the reverse-scored item. To calculate a score for each personality trait, we translated these categories into numbers ranging from one to five (where one indicates “totally disagree” and five indicates “totally agree”) for the standard items and numbers ranging from five to one for the reverse-scored items. The score for each Big Five personality trait is the average of the scores for the corresponding items and ranges from one to five.

Individual financial literacy is measured based on the three items designed by Lusardi and Mitchell [18]. This scale is widely accepted and aims to reveal respondents’ fundamental economic and finance knowledge. Accordingly, the respondents were asked three questions concerning interest rates, inflation, and risk diversification (see Table A.1 in the Appendix). Our measure for financial literacy is the sum of the correct answers and thus ranges between zero and three.

Given the importance of social norms in determining participation in community renewable energy projects [11], we include several variables to capture different layers of social interaction and contextual factors. As investment decisions and the intention to invest cannot be observed by others, people need to discuss their (sustainable) investment behavior with others to signal pro-environmental behavior [23]. Further, word-of-mouth learning could be an important driver of investment decisions [66]. Therefore, in line with Riedl and Smeets [23], we additionally construct the dummy variable “talk about investments,” which takes the value one if the respondent agreed with the statement “I often talk to others about investments.” To measure potential signaling motives, we follow Schwirplies and

Ziegler [56] and construct the dummy variable “act as example,” which takes the value one if the respondent agreed with the statement “I act sustainably to set an example for others.”

To indicate whether the respondent is already active in a volunteering social context, we include the variable “volunteering,” which takes the value one if the respondent indicated already being engaged in voluntary work [22,24]. Perceived expectations of peers are captured in line with, for example, Gutsche et al. [36] or Groh and v. Möllendorff [59]. Accordingly, the dummy variable “expectations social environment” takes the value one if the respondent agreed with the statement “My social environment (e.g., family, friends, colleagues) expects me to behave sustainably.”

To address concerns about merging the two sub-samples into one sample, we compared the descriptive statistics of all dependent and explanatory variables and found that the two samples are not systematically different from each other (see Table A.2 in the Appendix). Moreover, compared to the general German population in 2018, we find that the respondents in our sample are on average older (49.67 years vs. 44.40 years), largely male (60% vs. 49%), and have higher levels of education (61% vs. 32%). These findings are in line with our expectations, as our sample is representative for rather experienced financial decision-makers in German households and not for the entire German population.

### *3.3. Econometric strategy*

Our empirical analysis is conducted in several consecutive steps. First, we analyze descriptive statistics to determine how many respondents are members of or familiar with energy cooperatives at all. This allows us to compare the individual characteristics of members, non-members who intend to participate, and non-members who do not intend to participate in an energy cooperative. In the following steps, we restrict our sample to those respondents who indicated being familiar with energy cooperatives in order to increase the reliability of our results. As the results of a purely descriptive analysis can be blurred due to multiple relationships between the explanatory variables, we conduct a multiple regression analysis to control for several factors simultaneously. To this end, we apply bivariate binary probit models [67] that account for the binary nature of the dependent variables as well as the strong connection between both dependent variables. Additionally, we apply not only univariate binary models, but also bivariate and univariate ordered probit models for alternative variables reflecting the original ordinal scale of our dependent variables. As these approaches lead to similar estimation results, we only consider the results of the bivariate binary probit models in the following.

## 4. Results

### 4.1. Descriptive statistics

Table 1 provides an overview of the respondents’ familiarity with and membership of energy cooperatives. About 38% of all 4,250 respondents indicate being familiar with the term “energy cooperative,” and thus a majority of 62% indicates that they are either not familiar with energy cooperatives (53.30%) or not sure (8.57%). After this initial question, we only asked the former group further questions related to energy cooperatives. Of those, 117 persons (i.e., 7.29%) indicated that they were members of an energy cooperative. However, only 74 of those 117 respondents also indicated that they owned cooperative shares. As ownership of shares is a necessary condition for obtaining membership in energy cooperatives, we only consider those 74 respondents in the following analysis. Thus, 1.76% of all 4,210 respondents already participate in energy cooperatives. This value seems to be reasonably low given that about 180,000 citizens were members of German energy cooperatives in Germany in 2015.

Table 1: Overview of familiarity with and membership in energy cooperatives

Question	Yes	No	Don’t know	Total
Are you familiar with the term “energy cooperative”?	1,605 (38.12%)	2,244 (53.30%)	361 (8.57%)	4,210 (100%)
Are you a member of an energy cooperative?	117 <sup>a</sup> (7.29%)	1,472 (91.71%)	16 (1.00%)	1,605 (100%)

Notes: <sup>a</sup> Thereof, 74 respondents indicated to hold cooperative shares.

Table 2 reports how respondents perceive energy cooperatives. We find that approximately 75% of the respondents have positive associations with energy cooperatives. This is in line with Kalkbrenner and Roosen [11], who observed that 61.8% of their respondents have a positive attitude towards community-based renewable energy projects. The table further reveals that participation in energy cooperatives is perceived as a form of environmental engagement and as a financial investment to an equal extent, as 74.27% (73.58%) of the respondents agree that energy cooperative membership means making an individual contribution to energy transition and climate protection (financial investment).

In the following, we not only focus on respondents indicating that they are familiar with energy cooperatives but also distinguish between members and non-members. Figure 1 presents the responses of non-members to the questions concerning their willingness to volunteer and invest in energy cooperatives. The figure shows that a fairly substantial share

Table 2: Perceptions of energy cooperatives among people who are familiar with energy cooperatives (N = 1,605)

Topic	Response scale, absolute and relative frequencies					
	Very negative	Rather negative	Undecided	Rather positive	Very positive	Don't know
Associations with energy cooperatives	16 (1.00%)	92 (5.73%)	295 (18.38%)	831 (51.78%)	353 (21.99%)	18 (1.12%)
Membership perceived as ...	Totally disagree	Rather disagree	Undecided	Rather agree	Totally agree	Don't know
... investment	30 (1.87%)	96 (5.98%)	259 (16.14%)	754 (46.98%)	427 (26.60%)	39 (2.43%)
... individual contribution to energy transition and climate protection	28 (1.74%)	92 (5.73%)	260 (16.20%)	692 (43.12%)	500 (31.15%)	33 (2.06%)

of the respondents indicated a high willingness to volunteer for (36%) or to invest (43%) in energy cooperatives. These numbers are in the same range as that reported by Kalkbrenner and Roosen [11]. In contrast to the findings of Kalkbrenner and Roosen, however, our respondents seem to be slightly more willing to invest than to volunteer, which could be due to the restriction on experienced financial decision-makers in our study.

While Figure 1 neglects the interdependence between the two dimensions of participation, Table 3 sheds further light on this issue. The table shows that the majority of the respondents (51.35%) are willing to participate in at least one of the two possible ways. About 28% indicated a high willingness to volunteer and to invest at the same time, and about 46% of the respondents indicated not a high willingness to participate in either case. Thus, in line with Kalkbrenner and Roosen [11] for Germany and Koirala et al. [13] for the Netherlands, we find a substantial potential for citizen participation in community renewable energy.

To obtain initial insights into potential drivers of the willingness to participate as well as potential differences between members and non-members of energy cooperatives, Table 4 characterizes these groups by the various explanatory variables defined above. Focusing on socio-demographic variables first, we see that members of energy cooperatives tend to be younger (47.69 vs. 51.03 years), are generally male (78% vs. 66%), and have a higher educational level (70% vs. 64%) than non-members on average. The share of respondents with a household net income above the median class is also higher among members (72%

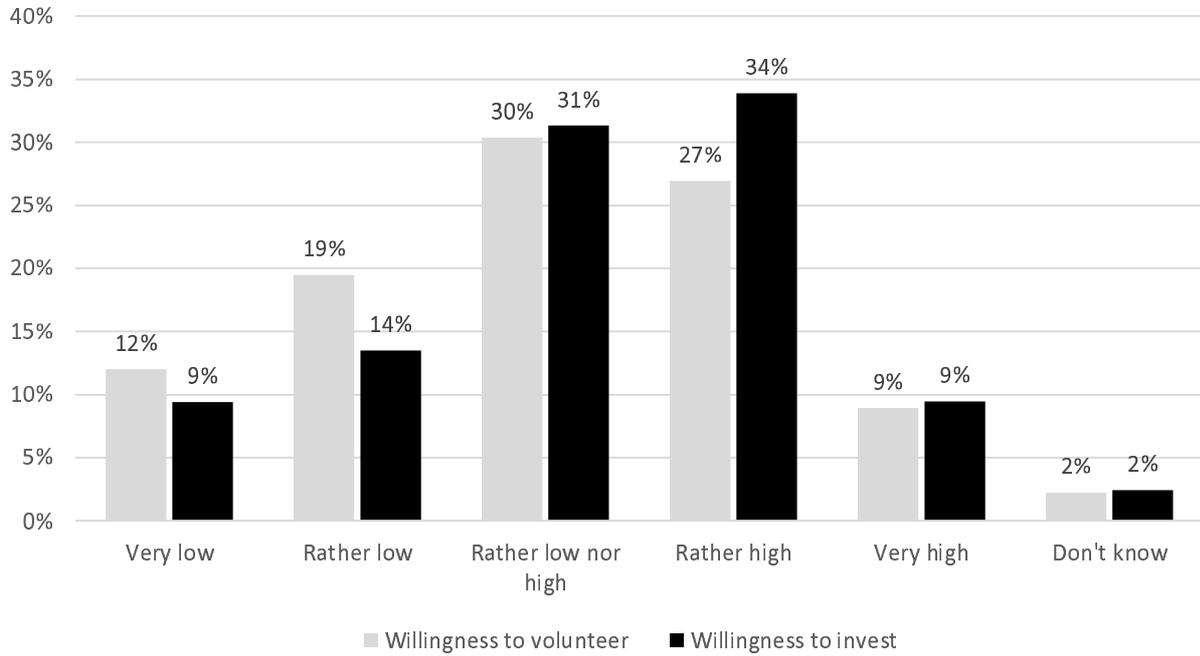


Figure 1: Citizens' willingness to volunteer and invest in energy cooperatives (N = 1,488)

Table 3: Relationship between high willingness to volunteer and high willingness to invest (N = 1,488)

		High willingness to invest			
		No	Yes	Missing values	Total
High willingness to volunteer	No	680 (45.70%)	223 (14.99%)	17 (1.14%)	920 (61.83%)
	Yes	115 (7.73%)	415 (27.89%)	4 (0.27%)	534 (35.89%)
	Missing values	12 (0.81%)	7 (0.47%)	15 (1.01%)	34 (2.28%)
	Total	807 (54.23%)	645 (43.35%)	36 (2.42%)	1,488 (100.00%)

vs. 49%).<sup>4</sup> In contrast, we find no differences with respect to the regional context variables “rural region” and “Western Germany.”

We find similar differences among non-members grouped by their indicated willingness to volunteer and to invest, respectively. Non-members’ willingness to participate in energy cooperatives seems to be negatively related to age and positively related to having a high education as well as a higher household net income. Moreover, women less frequently indicated a high willingness to invest in energy cooperatives (37% vs. 31%). Again, we find no differences for the two regional variables.

With respect to our attitudinal factors, the descriptive statistics are mostly in line with our expectations. While there is no significant difference between members and non-members with regard to warm glow, we see that the share of respondents indicating that they feel good when acting sustainably is larger among those who state a high willingness to participate. Similarly, we find higher average NEP scores for this group, indicating stronger environmental values. Interestingly, we also find a higher average NEP score among non-members compared to members. With regard to political identification, we see that members tend to be more conservatively, liberally, socially, and ecologically oriented compared to non-members. This finding might reflect the general notion that members of cooperatives may be driven by a desire to be politically active. It also shows that people from all political affiliations are active in energy cooperatives, not only left-aligned persons. Nevertheless, among non-members, individuals belonging to the latter group (i.e., persons with a social or ecological political orientation) tend to be more willing to participate in energy cooperatives. For liberal persons, this only holds with respect to the willingness to invest in energy cooperatives. We find no significant differences with respect to conservatively oriented persons. With regard to our measures for perceived benefits and costs, we see that members more often perceive the returns of sustainable equity funds as being higher compared to conventional equity funds than non-members (34% vs. 20%). Notably, the share of persons perceiving sustainable equity funds to be riskier than conventional equity funds is also higher among members. This could indicate that energy cooperatives might be an investment alternative for those who prefer to invest in a sustainable manner but perceive the risk-return profiles of sustainable equity funds as inadequate.

With respect to economic preferences, the identified differences between members and non-members are generally not in accordance with patterns emerging for the non-members’

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<sup>4</sup> The corresponding mean or proportion comparison tests show that these differences are also statistically significant. This also applies to all of the following differences in characteristics that we highlight in the description.

Table 4: Characteristics of members and non-members who are familiar with energy cooperatives

Variable	Total			Members		Non-members			
	Mean	Min	Max			High willingness to volunteer		High willingness to invest	
						No	Yes	No	Yes
Number of observations	1,605			74 <sup>b</sup>	1,472 <sup>b</sup>	920	534	807	645
Age	50.59	18	89	47.69	51.03	51.86	49.23	51.60	50.05
Female	0.34	0	1	0.22	0.34	0.35	0.32	0.37	0.31
High education	0.64	0	1	0.70	0.64	0.62	0.67	0.61	0.67
HH net income above median class <sup>a</sup>	0.50	0	1	0.72	0.49	0.47	0.52	0.42	0.57
Rural region	0.17	0	1	0.19	0.17	0.17	0.18	0.17	0.18
Western Germany	0.79	0	1	0.81	0.79	0.79	0.80	0.78	0.81
Warm glow	0.80	0	1	0.77	0.80	0.74	0.90	0.74	0.88
Act as example	0.65	0	1	0.73	0.64	0.56	0.78	0.55	0.75
NEP	4.57	0	6	4.24	4.59	4.52	4.70	4.46	4.74
Conservative political identification	0.31	0	1	0.43	0.30	0.32	0.28	0.32	0.29
Liberal political identification	0.41	0	1	0.50	0.40	0.40	0.43	0.38	0.45
Social political identification	0.67	0	1	0.73	0.67	0.62	0.75	0.60	0.75
Ecological political identification	0.62	0	1	0.77	0.60	0.53	0.74	0.51	0.72
Perceived higher returns SRI	0.21	0	1	0.34	0.20	0.13	0.31	0.14	0.27
Perceived higher risk SRI	0.25	0	1	0.32	0.24	0.22	0.29	0.22	0.27
Risk taking	0.39	0	1	0.36	0.39	0.34	0.48	0.34	0.45
Patience	0.72	0	1	0.72	0.71	0.66	0.82	0.65	0.81
Altruism	0.67	0	1	0.73	0.67	0.62	0.76	0.61	0.74
Trust	0.87	0	3	0.84	0.87	0.83	0.96	0.78	1.00
Positive reciprocity	2.67	0	3	2.46	2.69	2.67	2.73	2.64	2.76
Negative reciprocity	0.62	0	3	0.91	0.60	0.56	0.68	0.55	0.67
Openness to experiences	3.85	1	5	3.69	3.85	3.79	3.97	3.80	3.93
Conscientiousness	4.27	1.5	5	3.95	4.30	4.30	4.29	4.29	4.31
Extraversion	2.85	1	5	3.00	2.84	2.75	3.00	2.77	2.94
Agreeableness	3.84	1	5	3.64	3.85	3.82	3.91	3.83	3.88
Emotional stability	3.80	1	5	3.70	3.81	3.79	3.85	3.77	3.88
Financial literacy	2.51	0	3	2.46	2.53	2.53	2.52	2.49	2.58
Talk about investments	0.38	0	1	0.53	0.37	0.29	0.51	0.28	0.49
Volunteering	0.43	0	1	0.66	0.41	0.35	0.52	0.36	0.48
Expectations social environment	0.45	0	1	0.59	0.44	0.36	0.59	0.36	0.55

Notes: <sup>a</sup> Due to missing values, the number of observations is lower than 1,605, 74, 1,472, 920, 534, 807, and 645, respectively. <sup>b</sup> The numbers of members (74) and non-members (1,472) do not add up to the total number of respondents who indicated that they are familiar with energy cooperatives, as 16 respondents answered that they do not know whether they are member of an energy cooperative, and 43 respondents indicated to be a member but held no cooperative shares and therefore were excluded from the analysis.

willingness to participate. This means that while we see no significant differences between members and non-members in terms of risk preferences, time preferences, altruism, and trust, we find that these factors are all positively related to the willingness to participate in energy cooperatives among non-members. Additionally, members score lower on positive reciprocity, but this variable is positively related to the non-members' intention to participate. Only negative reciprocity is positively related to membership as well as the willingness to participate in energy cooperatives. This finding may indicate that these persons have a different sense of justice than their corresponding counterparts.

We also find only small differences with respect to personality traits. Comparing members and non-members reveals that members score significantly lower on openness to experiences, conscientiousness, and agreeableness. There are no significant differences in terms of extraversion and emotional stability. However, we find that openness to experiences and extraversion are positively related to a high willingness to participate. Agreeableness is solely positively related to the willingness to volunteer, and emotional stability is positively related to the willingness to invest. There are no significant patterns in this regard for conscientiousness. In addition, we find that members are less financially literate than non-members on average. Interestingly, however, we find that respondents with a high willingness to invest in energy cooperatives have higher financial literacy scores on average, a pattern that we do not find for the willingness to volunteer, which emphasizes the importance of this variable when it comes to investment decisions.

Our descriptive results are further in line with previous studies highlighting the importance of social norms and other contextual factors for participation in community energy projects [11]. We see that signaling motives, measured by “act as example” and “talk about investments,” as well as perceived expectations of the social environment are more strongly pronounced among members than non-members. Further, 66% of the members and solely 41% of the non-members state to be already engaged in volunteering. Nevertheless, these patterns also emerge with respect to both dimensions of the willingness to participate among non-members, which highlights the importance of social norms and the behavior of peers for the intention to participate in energy cooperatives.

These results reveal a strong relationship between the willingness to volunteer and to invest and that they might be driven by the same determinants. This finding strengthens our empirical strategy, that is, to consider both dimensions simultaneously in bivariate regression approaches.

#### 4.2. Estimation results

The previously presented empirical analysis exclusively considered simple pairwise relationships and neither allows for the determination of the relative importance of the potential determinants nor controls for other factors simultaneously. Therefore, in the following, we analyze the relevance of the various potential determinants in a regression framework as outlined in Section 3.3.

Table 5 presents the Maximum Likelihood (ML) estimates of parameters in bivariate binary probit models. We consider two different specifications, as the analysis reveals potential multicollinearity between our indicators for political orientation and other factors, such as “altruism” or “warm glow.” Nevertheless, most results are stable across both and other, non-reported specifications.

With respect to the socio-demographic variables, we see that most of the patterns revealed in the previous descriptive analysis disappear after controlling for other factors. While the signs of the estimated parameters are in line with the previous results, we only find significant correlations for “female” and “HH net income above median class.” The variable “female” is significantly negatively related to the probability of indicating a high willingness to volunteer or to invest. However, the estimated impact is larger for the first case; this reveals that men are generally more likely to participate in energy cooperatives. This finding is in line with the fact that 76% of the respondents who were members of an energy cooperative are male and is also in accordance with the results obtained by Kalkbrenner and Roosen [11]. The households’ net income is only significantly positively related to the probability of stating a high willingness to invest in energy cooperatives, which indicates the importance of disposable financial means for investment decisions. We find no evidence concerning the importance of our regional context factors “rural region” and “Western Germany” as was the case in earlier studies [11,14].

With respect to our attitudinal variables, we find mixed results. Feelings of warm glow are (weakly) significantly and positively related to both means of participation. However, the size of both estimated parameters drops and their significance vanishes after controlling for the various facets of individual political identification, indicating potential omitted variable bias. Our measure for pro-environmental orientation, the NEP score, is not significantly related to the probability of indicating a high willingness to participate. This is in contrast to Kalkbrenner and Roosen [11] or Koirala et al. [13] but is similar to the findings of Ziegler [39] regarding individuals’ acceptance of energy policy measures. Also in line with Ziegler’s [39] results, we find that having an ecological political identification seems to be more important,

Table 5: Maximum likelihood estimates (robust z-statistics) in bivariate binary probit models, dependent variables: “high willingness to volunteer” and “high willingness to invest”

Explanatory variables	(1)				(2)			
	High willingness to volunteer		High willingness to invest		High willingness to volunteer		High willingness to invest	
Age	-0.003	(-1.372)	-0.001	(-0.610)	-0.004	(-1.561)	-0.002	(-0.934)
Female	-0.231***	(-2.634)	-0.157*	(-1.840)	-0.238***	(-2.703)	-0.162*	(-1.879)
High education	0.107	(1.314)	0.081	(1.019)	0.090	(1.089)	0.054	(0.669)
HH net income above median class	0.050	(0.655)	0.333***	(4.439)	0.067	(0.864)	0.345***	(4.556)
Rural region	0.133	(1.334)	0.068	(0.698)	0.132	(1.317)	0.068	(0.704)
Western Germany	0.081	(0.872)	0.084	(0.925)	0.073	(0.776)	0.076	(0.822)
Warm glow	0.216*	(1.782)	0.205*	(1.843)	0.131	(1.063)	0.134	(1.180)
Act as example	0.320***	(3.389)	0.305***	(3.434)	0.289***	(3.041)	0.271***	(3.027)
NEP	0.006	(0.217)	0.037	(1.385)	-0.023	(-0.792)	0.011	(0.378)
Conserv. political identification	-	-	-	-	-0.045	(-0.527)	-0.053	(-0.610)
Liberal political identification	-	-	-	-	-0.089	(-1.122)	-0.029	(-0.374)
Social political identification	-	-	-	-	0.003	(0.028)	0.116	(1.251)
Ecological political identification	-	-	-	-	0.343***	(3.696)	0.277***	(3.007)
Perceived higher returns SRI	0.446***	(4.802)	0.348***	(3.768)	0.436***	(4.663)	0.334***	(3.594)
Perceived higher risk SRI	0.162*	(1.894)	0.119	(1.387)	0.183**	(2.118)	0.138	(1.607)
Risk taking	0.089	(1.096)	0.039	(0.497)	0.107	(1.311)	0.057	(0.727)
Patience	0.310***	(3.337)	0.261***	(2.954)	0.309***	(3.308)	0.252***	(2.809)
Altruism	0.177**	(1.999)	0.128	(1.507)	0.146	(1.644)	0.091	(1.065)
Trust	-0.014	(-0.333)	0.099**	(2.399)	-0.031	(-0.722)	0.080*	(1.907)
Positive reciprocity	-0.088	(-1.481)	0.005	(0.076)	-0.069	(-1.151)	0.013	(0.212)
Negative reciprocity	0.086**	(2.111)	0.103**	(2.544)	0.092**	(2.244)	0.108***	(2.681)
Openness to experiences	0.120**	(2.000)	0.055	(0.932)	0.102*	(1.669)	0.035	(0.580)
Conscientiousness	-0.109	(-1.636)	-0.084	(-1.272)	-0.099	(-1.464)	-0.073	(-1.090)
Extraversion	0.067	(1.552)	0.036	(0.836)	0.078*	(1.775)	0.046	(1.062)
Agreeableness	0.034	(0.541)	-0.019	(-0.310)	0.037	(0.594)	-0.021	(-0.340)
Emotional stability	-0.010	(-0.181)	0.030	(0.559)	-0.008	(-0.153)	0.034	(0.628)
Financial literacy	0.041	(0.764)	0.112**	(2.119)	0.048	(0.885)	0.117**	(2.198)
Talk about investments	0.281***	(3.467)	0.360***	(4.541)	0.279***	(3.414)	0.355***	(4.449)
Volunteering	0.359***	(4.623)	0.139*	(1.835)	0.361***	(4.616)	0.132*	(1.732)
Expectations social environment	0.287***	(3.581)	0.183**	(2.337)	0.267***	(3.280)	0.160**	(2.026)
Constant	-1.788***	(-4.721)	-1.939***	(-5.236)	-1.753***	(-4.611)	-1.890***	(-5.057)
Log likelihood	-1462.587				-1450.346			
Number of observations	1,360							

Notes: (\*\*, \*\*\*) means that the corresponding parameter is different from zero at the 10% (5%, 1%) significance level.

as indicated by the highly significant and positive correlations between “ecological political identification” and both means of participation. Furthermore, none of the parameters for the other three political identifications are significantly different from zero. With regard to perceived benefits, our results are in line with previous studies [36], as we find that the parameters for “perceived higher returns SRI” are positive and significantly different from zero in both models. This suggests that persons who perceive sustainable investments (or, in particular, sustainable equity funds) as being more profitable than their conventional counterparts are more likely to participate in energy cooperatives. Interestingly, we also find a weak significant positive correlation between “perceived higher risk SRI” and the probability of indicating a high willingness to volunteer. This might indicate that persons who perceive SRI as excessively risky and thus do not invest in sustainable investment products could attempt to participate in the transition process via volunteerism.

With regard to economic preferences, three patterns emerge. First, patient persons are more likely to be highly willing to participate in energy cooperatives. Second, high levels of trust are positively associated with the intention to invest. This is in line with previous studies showing the importance of trust with regard to investment decisions [43, 44,68]. However, we find a significant correlation between “trust” and “high willingness to volunteer.” This confirms the results obtained by Kalkbrenner and Roosen [11], who found a positive relationship between trust and general willingness to participate in a community energy project (i.e., without differentiating between the two forms of participation). Our analysis shows that trust seems to be more important for investment decisions than for the decision to volunteer. We additionally find a significant correlation between “altruism” and “high willingness to invest” in the first model specifications, but this effect vanishes after controlling for political identification, which is again a signal of potential omitted variable bias. Nevertheless, we find a very strong and stable positive relationship between “negative reciprocity” and both forms of participation. This finding matches the observed differences between members and non-members and might indicate a higher sense of justice among both members and non-members with a high intention to participate compared to their corresponding counterparts. Negative reciprocity as a determinant for volunteering and investment intentions might be a relevant correlate that has been overlooked thus far. Since half of the German population has an intermediate level of negative reciprocity [63], further research on the correlation between negative reciprocity and environmental engagement might be fruitful.

Concerning personality traits, we see only a weak relationship with the probability to participate. Interestingly, none of the Big Five personality traits is significantly related to willingness to invest. Nevertheless, in line with volunteerism research [24,41], we find that persons who are both open to new experiences and extraverted are more likely to be highly willing to volunteer. With respect to individual capabilities, we see that financially literate persons are more likely to indicate a high willingness to invest. The importance of financial literacy, particularly when it comes to investment decisions, is supported by the fact that we find no significant relationship between this variable and volunteering intentions.

Finally, our findings also underline the importance of social norms and further contextual factors for the willingness to participate in energy cooperatives, which connects to, but also extends, previous empirical evidence [11]. The indicators “talk about investments,” “expectations social environment,” and “volunteering,” are significantly positively related to the probability of stating a high willingness to participate in energy cooperatives and thus to both means of participation. This supports the argument that social signaling, word-of-mouth learning, and perceived social norms are important factors for participation.

## 5. Conclusion and discussion

Citizen participation seems to be essential to sustain a high level of public support for the energy transition. Therefore, it is crucial to develop participation schemes that allow citizens to participate in an adequate manner. Energy cooperatives are seen as a promising participation scheme even if the number of members of such cooperatives remains small today. Against this backdrop, our study explores the potential of German households to participate. Building on the work of Kalkbrenner and Roosen [11], we study the determinants of the two main aspects of participation in energy cooperatives, namely volunteer work and making an investment. In doing so, we restrict our analysis to financial decision-makers who are not yet members of an energy cooperative but are familiar with this form of participation. In addition, we extend the work of Kalkbrenner and Roosen [11] by systematically integrating determinants that have been identified in research on socially responsible investment and volunteerism.

In summary, we see that the majority of respondents (62%) are yet not familiar with energy cooperatives at all, indicating the potential of information campaigns. However, about 40% of those who are already familiar with energy cooperatives indicate a high willingness to participate. Our analysis shows that members and non-members generally differ in terms of several characteristics, but non-members indicating a high willingness to participate in

energy cooperatives are similar to members with respect to not only socio-demographic variables but also regarding personal attitudes, such as ecological political orientation, the motivation to act sustainably as an example for others, and the two economic preferences altruism and negative reciprocity. Participation intention in general correlates with particular social contextual factors and social interactions, namely that family, friends and colleagues approve sustainable behavior, that people have been previously volunteered, and that they often discuss investments with others. This finding suggests that energy cooperatives themselves should prefer interactive forms of member recruitment in the social environment over more anonymous forms. Financial participation is further driven by household income, individual financial literacy, trust, patience, and expectations with regard to the returns of SRI when compared to conventional investments. On the one hand, these results indicate that specific investor groups could be addressed by targeted information campaigns presenting simple and transparent information and long-term perspectives on how to participate in energy cooperatives, including the potential financial benefits of doing so. On the other hand, these findings suggest the importance of discussing whether and how individual financial education should be fostered and to what extent topics such as potential impacts of sustainable investments on climate policy should be included. From a methodological perspective, our results clearly show that econometric analyses benefit from the consideration of economic preferences, particularly time and social preferences, as explanatory variables. This indicates that future studies should take these factors into account to mitigate potential omitted variable bias. Nevertheless, personality traits seem to be of minor relevance in terms of explaining individual participation intentions.

Our study suggests that the population's willingness to participate is not a bottleneck in attempting to encourage broader participation in the energy transition. Mobilizing citizens who are willing to actively participate may contribute to maintaining high levels of acceptance for necessary feed-in tariffs [69] and renewable energies in general. Whether citizen participation in energy cooperatives also increases the acceptance of wind turbines and transmission grid infrastructure in citizens' direct neighborhoods is another question. Hyland and Bertsch [8] have convincingly shown that financial participation schemes may raise the acceptance of renewable energy infrastructure among specific groups in the population. However, it must be noted that the effect of fixed compensation schemes is greater than that of cooperative schemes, as citizens are not enthusiastic about sharing associated risks of project development.

A limitation of our study is that we only investigate participation intentions but do not consider actual participation behavior. Although intentions are seen as important prerequisite for participation behavior [70], the positive effects of such behavior will only occur when citizens actually participate. Since we investigate the willingness to participate, we emphasize in our study those personal and contextual factors that motivate the actions in question (i.e., attitudes, cognitive and non-cognitive skills, and social norms). To what extent this willingness leads to actual participation behavior (i.e., how the discrepancy between the willingness to participate and actual participation behavior can be overcome) is not the subject of our study. Here, we follow the approach of Koirala et al. [13] by disregarding the barriers to participation behavior in our regression analysis, such as lack of skills, savings, and/or disposable time. We use the classical socio-demographic variables (i.e., age, gender, income, education) as proxies for these factors, supplemented by geographical variables (e.g., most energy cooperatives are located in Western Germany). The extent to which these factors are reflected in the expression of our measures for the willingness to participate cannot be accurately assessed, as there is always space for respondents to interpret the measures in their own way. This means that it is not perfectly possible to disentangle the willingness to participate from the ability to participate. The question of how the gap between participation intentions and behavior can be bridged merits further research.

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## A. Appendix

Table A.1: Description of explanatory variables

Explanatory variable	Definition
Age	= the respondent's age in years.
Female	= one if the respondent is a woman.
High education	= one if the respondent's highest level of education is at least an advanced technical college certificate or a high school diploma.
HH net income above median class	= one if the respondent's household net income of the respondent is above the median class and thus amounts to 3,000€ or more. We asked the respondents to indicate their respective households' net income by selecting one out of 11 income intervals. The median interval is the class ranging from 2,500€ to below 3,000€.
Rural region	= one if the respondent lives in a thinly populated municipality.
Western Germany	= one if the respondent's main residence is in one of the West German federal states (excluding Berlin).
Warm glow	= one if the respondent rather or totally agreed with the statement "It makes me feel good to act sustainably." <sup>a</sup>
Act as example	= one if the respondent rather or totally agreed with the statement "I act sustainably to set an example for others." <sup>a</sup>
NEP	= index variable that ranges between zero and six. To construct this measure, the respondents were asked to indicate to what extent they agree with the following six statements: "Humans have the right to modify the natural environment to suit their needs," "Humans are severely abusing the planet," "Plants and animals have the same right to exist as humans," "Nature is strong enough to cope with the impacts of modern industrial nations," "Humans were meant to rule over the rest of nature," and "The balance of nature is very delicate and easily upset." <sup>a</sup> On this basis, we construct one dummy variable for each statement. In the case of positively worded statements (i.e., statements 2, 3, and 6), each dummy variable takes the value one if the respondent rather or totally agreed with the corresponding statement. In the case of negatively worded statements (i.e., statements 1, 4, and 5), each dummy variable takes the value one if the respondent rather or totally disagreed with the corresponding statement. The variable "NEP" is the sum of these six dummy variables.
Conservative political identification	= one if the respondent rather or totally agreed with the statement "I identify myself with conservative oriented politics." <sup>a</sup>
Liberal political identification	= one if the respondent rather or totally agreed with the statement "I identify myself with liberally oriented politics." <sup>a</sup>
Social political identification	= one if the respondent rather or totally agreed with the statement "I identify myself with socially oriented politics." <sup>a</sup>
Ecological political identification	= one if the respondent rather or totally agreed with the statement "I identify myself with ecologically oriented politics." <sup>a</sup>

Table A.1: Description of explanatory variables, continued

Explanatory variable	Definition
Perceived higher returns SRI	= one if the respondent perceived the returns of sustainable equity funds to be rather or much higher than the returns of conventional equity funds. The respondents were asked to indicate their perception on a symmetric scale with five ordered response categories: “much lower,” “rather lower,” “neither lower nor higher,” “rather higher,” and “much higher.”
Perceived higher risk SRI	= one if the respondent agreed rather or totally with the statement “Sustainable equity funds are riskier than conventional equity funds.” <sup>a</sup>
Risk taking	= one if the respondent indicated being rather or very willing to take risks in general. The respondents were asked to indicate their willingness to take risks on a symmetric scale with five ordered categories “completely unwilling to take risks,” “rather unwilling to take risks,” “undecided,” “rather willing to take risks,” and “very willing to take risks.”
Patience	= one if the respondent indicated being rather or very willing to give up something that is beneficial for them today in order to benefit more from it in the future. The respondents were asked to indicate their willingness on a symmetric scale with the five ordered categories “completely unwilling,” “rather unwilling,” “undecided,” “rather willing,” and “very willing.”
Altruism	= one if the respondent indicated being rather or very willing to give to good causes without expecting anything in return. The respondents were asked to indicate their willingness on a symmetric scale with the five ordered categories “completely unwilling,” “rather unwilling,” “undecided,” “rather willing,” and “very willing.”
Trust	= index variable that ranges between zero and three. To construct this measure, the respondents were asked to indicate to what extent they agreed with the following three statements: “In general, one can trust people,” “These days you cannot rely on anybody else,” and “When dealing with strangers, it is better to be careful before you trust them.” <sup>a</sup> On this basis, we construct one dummy variable for each statement. The first dummy variable takes the value one if the respondent rather or totally agreed with the first statement, while the other two dummy variables take the value one if the respondent rather or totally disagreed with the latter two statements. The variable “trust” is the sum of these three dummy variables.
Positive reciprocity	= index variable that ranges between zero and three. To construct this measure, the respondents were asked to indicate to what extent they agreed with the following three statements: “If someone does me a favor, I am willing to return it,” “I am particularly trying to help someone who has helped me before,” and “I am willing to pay costs to help someone who has helped me before.” <sup>a</sup> On this basis, we construct one dummy variable for each statement. Each dummy variable takes the value one if the respondent rather or totally agreed with the corresponding statement. The variable “positive reciprocity” is the sum of these three dummy variables.

Table A.1: Description of explanatory variables, continued

Explanatory variable	Definition
Negative reciprocity	= index variable that ranges between zero and three. To construct this measure, the respondents were asked to indicate to what extent they agreed with the following three statements: “If I am faced with a great injustice, I will avenge myself at the next opportunity,” “If someone puts me in a difficult position, I’ll do the same to him,” and “If someone insults me, I will also be offensive to him.” <sup>a</sup> On this basis, we construct one dummy variable for each statement. Each dummy variable takes the value one if the respondent rather or totally agreed with the corresponding statement. The variable “negative reciprocity” is the sum of these three dummy variables.
Openness to experiences	= index variable that ranges between one and five. To construct this measure, the respondents were asked to indicate to what extent they agreed that the following two pairs of character traits apply to them: “Open to new experiences, complex” and “Conventional, uncreative.” The respondents were asked to respond using a scale with five ordered response categories: “totally disagree,” “rather disagree,” “undecided,” “rather agree,” and “totally agree.” To calculate a score, we translated the categories into numbers ranging from one to five (where one represents “totally disagree” and five “totally agree”) for the first pair and numbers ranging from five to one for the second pair (i.e., the reverse-scored items). The score for “openness to experiences” is the average of these two scores.
Conscientiousness	= index variable that ranges between one and five. To construct this measure, the respondents were asked to indicate to what extent they agreed that the following two pairs of character traits apply to them: “Dependable, self-disciplined” and “Disorganized, careless.” The respondents were asked to answer on a scale with five ordered response categories: “totally disagree,” “rather disagree,” “undecided,” “rather agree,” and “totally agree.” To calculate a score, we translated the categories into numbers ranging from one to five (where one represents “totally disagree” and five “totally agree”) for the first pair and numbers ranging from five to one for the second pair (i.e., the reverse-scored items). The score for “conscientiousness” is the average of these two scores.
Extraversion	= index variable that ranges between one and five. To construct this measure, the respondents were asked to indicate to what extent they agreed that the following two pairs of character traits apply to them: “Extraverted, enthusiastic” and “Reserved, quiet.” The respondents were asked to answer on a scale with five ordered response categories: “totally disagree,” “rather disagree,” “undecided,” “rather agree,” and “totally agree.” To calculate a score, we translated the categories into numbers ranging from one to five (where one represents “totally disagree” and five “totally agree”) for the first pair and numbers ranging from five to one for the second pair (i.e., the reverse-scored items). The score for “extraversion” is the average of these two scores.

Table A.1: Description of explanatory variables, continued

Explanatory variable	Definition
Agreeableness	= index variable that ranges between one and five. To construct this measure, the respondents were asked to indicate to what extent they agreed that the following two pairs of character traits apply to them: “Sympathetic, warm” and “Critical, quarrelsome.” The respondents were asked to answer on a scale with five ordered response categories: “totally disagree,” “rather disagree,” “undecided,” “rather agree,” and “totally agree.” To calculate a score, we translated the categories into numbers ranging from one to five (where one represents “totally disagree” and five “totally agree”) for the first pair and numbers ranging from five to one for the second pair (i.e., the reverse-scored items). The score for “agreeableness” is the average of these two scores.
Emotional stability	= index variable that ranges between one and five. To construct this measure, the respondents were asked to indicate to what extent they agreed that the following two pairs of character traits apply to them: “Calm, emotionally stable” and “Anxious, easily upset.” The respondents were asked to answer on a scale with five ordered response categories: “totally disagree,” “rather disagree,” “undecided,” “rather agree,” and “totally agree.” To calculate a score, we translated the categories into numbers ranging from one to five (where one represents “totally disagree” and five “totally agree”) for the first pair and numbers ranging from five to one for the second pair (i.e., the reverse-scored items). The score for “emotional stability” is the average of these two scores
Financial literacy	= index variable that ranges between zero and three. To construct this measure, the respondents were asked to answer the following three questions and corresponding response categories: “Imagine you have 100 € in a savings account and the interest rate is 2% per year. Please give your estimate of how much money you would have on the savings book after five years if you never withdraw money or interest payments during this time,” with the response options being “less than 102 €,” “exactly 102 €,” “more than 102 €,” “don’t know;” “Imagine that the interest rate on your savings book is 1% per year and inflation is 2% per year. Please give your estimate of how much you could buy with the money in your savings account after one year,” with the response categories being “less than today,” “exactly the same,” “more than today,” “don’t know;” “Please state your opinion as to whether the following statement is true or false: The purchase of an individual share usually has a more secure return than an equity fund,” with the response option being “right,” “wrong,” “don’t know.” The score for financial literacy is the sum of the correct answers.
Talk about investments	= one if the respondent rather or totally agreed with the statement “I often talk to others about investments.” <sup>a</sup>
Volunteering	= one if the respondents indicated engaging in volunteer work.
Expectations social environment	= one if the respondent rather or totally agreed with the statement “My social environment (e.g. family, friends, colleagues) expects me to behave sustainably.” <sup>a</sup>

Notes: <sup>a</sup> The respondents were asked to indicate to what extent they agreed with the corresponding statement on a symmetric scale with the five ordered response categories “totally disagree,” “rather disagree,” “undecided,” “rather agree,” and “totally agree.”

Table A.2: Overview of characteristics of gross samples and the German population

Variable	Total	Sample 1	Sample 2	German population in 2018
Number of observations	4,210	1,710	2,500	82.79 million <sup>c</sup>
Age	49.67	50.47	49.12	44.40 <sup>d</sup>
Female	0.40	0.41	0.38	0.51 <sup>e</sup>
High education	0.61	0.57	0.64	0.32 <sup>f</sup>
HH net income above median class <sup>a</sup>	0.45	0.44	0.46	-
Rural region	0.16	0.17	0.15	-
Western Germany	0.79	0.78	0.79	0.85 <sup>b,g</sup>
Warm glow	0.77	0.78	0.77	-
Act as example	0.60	0.62	0.59	-
NEP	4.54	4.49	4.57	-
Conservative political identification	0.28	0.29	0.28	-
Liberal political identification	0.38	0.40	0.36	-
Social political identification	0.64	0.64	0.64	-
Ecological political identification	0.55	0.56	0.54	-
Perceived higher returns SRI	0.18	0.18	0.19	-
Perceived higher risk SRI	0.22	0.22	0.22	-
Risk taking	0.33	0.32	0.33	-
Patience	0.64	0.62	0.66	-
Altruism	0.64	0.63	0.64	-
Trust	0.78	0.77	0.79	-
Positive reciprocity	2.60	2.56	2.62	-
Negative reciprocity	0.60	0.66	0.55	-
Openness to experiences	3.75	3.74	3.76	-
Conscientiousness	4.26	4.24	4.28	-
Extraversion	2.79	2.78	2.80	-
Agreeableness	3.83	3.85	3.82	-
Emotional stability	3.73	3.74	3.73	-
Financial literacy	2.42	2.39	2.44	-
Talk about investments	0.31	0.32	0.31	-
Volunteering	0.35	0.33	0.35	-
Expectations social environment	0.40	0.43	0.39	-

Notes: <sup>a</sup> Due to missing values, the number of observations is lower than 4,210, 1,710, or 2,500, respectively. <sup>b</sup> In contrast to our definition, this number includes inhabitants from Berlin and is thus larger. <sup>c</sup> Destatis, Bevölkerung auf Grundlage des Zensus 2011 nach Geschlecht und Staatsangehörigkeit im Zeitverlauf. <https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bevoelkerung/Bevoelkerungsstand/Tabellen/liste-zensus-geschlecht-staatsangehoerigkeit.html>, 2020 (accessed 23 January 2020). <sup>d</sup> Statista, Durchschnittsalter der Bevölkerung in Deutschland nach Staatsangehörigkeit 2018. <https://de.statista.com/statistik/daten/studie/723069/umfrage/durchschnittsalter-der-bevoelkerung-in-deutschland-nach-staatsangehoerigkeit/> 2019, (accessed 23 January 2020). <sup>e</sup> Statista, Bevölkerung - Einwohnerzahl in Deutschland nach Geschlecht von 1995 bis 2018. <https://de.statista.com/statistik/daten/studie/161868/umfrage/entwicklung-der-gesamtbevoelkerung-nach-geschlecht-seit-1995/>, 2019 (accessed 23 January 2020). <sup>f</sup> Destatis, Bevölkerung im Alter von 15 Jahren und mehr nach allgemeinen und beruflichen Bildungsabschlüssen nach Jahren. <https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bildung-Forschung-Kultur/Bildungsstand/Tabellen/bildungsabschluss.html>, 2019, (accessed 23 January 2020). <sup>g</sup> Statista, Bevölkerung - Zahl der Einwohner in Ost- und Westdeutschland von 1991 bis 2018. <https://de.statista.com/statistik/daten/studie/1058251/umfrage/zahl-der-einwohner-in-ost-und-westdeutschland/>, 2019 (accessed 23 January 2020).