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Renewable Energy Communities

Exploring behavioral and motivational factors behind the willingness to participate in Renewable Energy Communities in Germany

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Abstract

Several studies and actors have emphasized the role of Renewable Energy Communities as collective citizen initiatives enhancing the decentralized, low-carbon energy transition. Despite the social, environmental, and economic benefits, several changes in the energy policies in Germany have led to a decrease of newly registered Renewable Energy Communities. Previous financial measures have failed to address vulnerable groups resulting in the underrepresentation of lower-income groups and women. This raises the question of which strategies, in addition to financial incentives, can encourage inclusive participation in Renewable Energy Communities.

The objective of this thesis is to gain a better understanding of the socio-psychological factors determining the willingness to participate in Renewable Energy Communities in Germany. Based on the Theory of Planned Behavior and the Norm Activation Model, this thesis analyzes the impact of self-interest and moral considerations on the willingness to participate. While the former assumes that behavior is the result of consciously evaluating the (social) costs and benefits, reflected in attitudes, subjective norms, and perceived behavioral control, the latter emphasizes the importance of moral considerations, reflected in personal norms. From a methodological point of view, a survey was conducted (N=298) to collect data among citizens living in Germany. The data is evaluated through statistical tests and regression models.

Findings reveal that both, self-interest and moral considerations play an important role in determining the willingness to participate. However, the influence of moral considerations is mediated through attitudes. Subjective norms are more important for women and medium as well as higher-income groups. The importance of socio-psychological determinants for the willingness to participate emphasizes that behavioral issues deserve much more consideration in the policy discourse. In turn, this highlights the role of contextual and behaviorally informed strategies to complement financial incentives encouraging participation in Renewable Energy Communities. Differences across income groups and gender highlight the need for target-specific strategies. Future areas of research are recommended.

Keywords: Renewable Energy Communities, willingness to participate, behavioral insights

Executive Summary

Background and problem definition

The transition to a decentralized energy system offers the chance to reduce carbon emissions by introducing more renewable energy technologies, while simultaneously allowing more co-determination through various actors, such as citizens. This not only ensures a technical but also social transformation towards a more just energy system (Goldthau, 2014; Heldeweg & Saintier, 2020). In fact, already today individual and collective citizen initiatives are one of the main drivers behind the implementation of decentralized renewable energy sources (Bündnis Bürgerenergie e.V., 2019). Specifically, Renewable Energy Communities (RECs) allow citizens to jointly invest and (co-)own renewable energy projects generating several social, environmental, and economic benefits at the local level.

The implementation of RECs has been promoted by citizens, environmental organizations as well as politicians as a measure to increase decentralized energy technologies (Bündnis Bürgerenergie e.V., 2020a; Greenpeace Energy, 2020). The European Renewable Energy Directive (RED II) legally defines RECs and demands the Member States to implement an inclusive enabling framework to further support their development. Although Germany is one of the European countries with higher numbers of RECs, the current trend of newly registered RECs is decreasing, as financial support conditions were changed and the regulatory framework has been considered inadequate (Morris, 2019). Looking at the current membership, low-income groups, as well as women, appear to be less represented (Radtke, 2014). The homogeneity indicates the risk of reproducing social inequalities among gender and income groups.

Whereas strategies encouraging the willingness of citizens to engage in RECs are important in the current policy discourse, most of the attention is given to financial incentives. Much less is known about behavioral determinants behind the willingness to participate (WTP) in RECs. The analysis of the WTP gives information about the potential of future RECs and analyzes the drivers for participation (Bauwens, 2016). While there is a large body of literature on the socio-psychological determinants of pro-environmental energy-related behavior in general, only a few studies have directly addressed the WTP in community energy projects in Germany. However, the studies to date have lacked a theoretical foundation informing the relationship between socio-psychological determinants and the WTP, and the influence of attitude, perceived behavioral control, and personal norm, has not been tested yet. This perspective is important in order to understand behavior and potentially develop strategies encouraging the WTP. The thesis at hand aims to address this knowledge gap.

Research objective and questions

The overall objective of this thesis is to gain a better understanding of the socio-psychological factors determining the WTP in RECs in Germany. Specifically, the thesis focuses on the influence of self-interest and moral considerations on the WTP in RECs. In turn, based on this new body of knowledge, strategies addressing the behavioral factors can be developed.

This thesis addresses the following research questions. Due to the underrepresentation of low-income groups and women in RECs, particular interest is given to differences in the socio-psychological determinants and their influence on the WTP across income groups and gender.

RQ1: What influence does self-interest have on the willingness to participate in Renewable Energy Communities?
RQ2: Additional to self-interest, what influence do moral considerations have on the willingness to participate in Renewable Energy Communities?
RQ3: How does the influence of self-interest and moral considerations on the willingness to participate in Renewable Energy Communities differ between gender and income groups?

Figure 0-1: Research questions

Research design and methodology

In terms of data collection, a cross-sectional online survey among 298 citizens living in Germany was conducted. The survey aimed at collecting primary data about the socio-psychological factors as well as the WTP in RECs. Non-probability sampling was applied to gather the data. In terms of data analysis, the relationship among the variables was examined with (partial) correlations as well as stepwise, multivariate linear regressions. Non-parametric tests provided additional insight into the comparison across income groups and gender. Statistical and regression estimates were produced with the software STATA 16.

The Theory of Planned Behavior (TPB) and the Norm-Activation Model (NAM) provide the theoretical foundations for this thesis. The TPB is based on the assumption that behavior is the result of consciously evaluating the costs and benefits of the specific action. The theory assumes that the WTP is based on the attitude towards the behavior, the social pressures by significant others represented through the subjective norm, and the perceived behavioral control over the situation. Thus, as a first step, the relationship between the TPB variables and the WTP in RECs is analyzed. The NAM instead emphasizes the importance of moral considerations reflected in personal norms. Hence, in a second step, the TPB model was extended by personal norms. It is argued that if people feel a strong moral obligation towards a behavior, they are more likely to act that way. To test the indirect effect of personal norms, a mediation analysis was carried out. Based on the results of the previous regressions, separate regression analyses for lower-, middle- and higher-income groups, as well as women and men, were conducted.

Results and implications

Overall, and with due limitations, a moderate but positive WTP was identified. Looking at the socio-psychological factors, the results indicate that the respondents have, on average, a positive attitude towards RECs and perceive rather high subjective norms and behavioral control regarding their potential participation in RECs. Those with relatively higher income as well as men perceive a higher control over their participation than lower-income groups and women. However, on average, the respondents do not show a very high personal norm regarding their participation.

The results of this study support the assumption based on the TPB that the WTP in RECs is dependent on self-interest and moral considerations. In fact, the attitude, subjective and personal norms, and perceived behavioral control significantly influence the WTP. Extending the TPB model by personal norm reveals that the effect of the personal norm is very small and insignificant. However, a mediation analysis suggests that, instead of a direct effect, the influence of personal norms is mediated through attitude. Additional to behavioral factors, the previous awareness and the income group have a significant effect on the WTP. The separate linear regressions for income groups and gender indicate that the WTP of lower-income groups and men is not determined by social approval compared to middle-/higher income groups and women.

The findings also suggest that while the TPB has a relatively high explanatory power, the personal norm does not add to it. This indicates that participation in RECs is perceived as costly and resource-intensive behavior. However, there is also unaccounted exploratory power in the model explaining the WTP, which highlights the relevance of other determinants, such as contextual factors, habits, and routines that deserve further analysis in future research. In fact, the results must be interpreted with due caution as the underlying data — notably derived from the small sample size — faces several limitations, especially concerning its external generalizability.

Conclusions and recommendations

The objective of this thesis was to gain a better understanding of the socio-psychological factors determining the WTP in RECs in Germany. The results indicate that self-interest and moral considerations both positively influence the WTP in RECs. However, self-interest is not only based on rational considerations but also includes normative, social, and moral considerations.

The importance of socio-psychological determinants of the WTP emphasizes that behavioral issues deserve much more consideration in the policy discourse. Based on the identified determinants, contextual and behaviorally informed strategies were identified. The former seeks to change the contextual factors, which influence the perceived behavioral control. The importance of a national regulatory framework, local governance as well as intermediaries and networks is emphasized. The latter aims to increase the WTP by directly addressing its antecedents - namely awareness, attitudes, social and personal norms as well as perceived behavioral control - through information, communication and framing, and capacity building. The differences in socio-psychological determinants and their relationship with the WTP highlight the importance of taking structural differences into account within behavioral studies.

Finally, the thesis identifies several areas for further research. Following the identification of contextual and behaviorally informed strategies that have the potential to encourage the WTP in RECs, as a next step, special attention must be given to the evaluation of their effectiveness. Further, future studies could assess the linkage between stated and revealed preferences. Special attention must also be given to other factors influencing the WTP in RECs, such as contextual factors as well as habits and routines. In terms of data, a larger and representative sample is crucial to enhance the external validity claims of this study.

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Abbreviations

CEEP	Clean Energy for All Europeans Package
CSOP	Consumer Stock Ownership Plans
EU	European Union
e.g.	"exempli gratia", for example
FIT(s)	Feed-in Tariffs
H	Hypothesis
i.e.	"id est", that is to say
IEMD	Internal Electricity Market Directive (EU) 2019/944
KW	Kilowatt
NAM	Norm-Activation Model
NECP	National Energy and Climate Plan
WTP	Willingness to participate
REC(s)	Renewable Energy Community/(-ies)
RED II	Renewable Energy Directive (EU) 2018/2001
RQ(s)	Research question(s)
TPB	Theory of Planned Behavior
VBN	Value-Belief-Norm Theory

1 Introduction

The increasing greenhouse gas emissions produced through human activity have been identified as the root cause of global warming (IPCC, 2018). The central aim of the Paris Agreement is to keep global warming well below 1.5 degrees Celsius compared to pre-industrial levels to lessen and decelerate climate change (IPCC, 2018). However, the current energy system in many European countries causes several environmental and social challenges. Firstly, energy systems are still predominantly based on fossil fuels (European Commission, 2020). With 75% of the European Union's (EU) greenhouse gas emissions, the energy sector is one of the biggest contributors to climate change (European Commission, 2020). Secondly, the energy system is mainly composed of centralized, large-scale electricity generation, transmission, and distribution facilities, leading to the dominance of a few incumbent players and inflexibility and inertia when it comes to systems change (Goldthau, 2014; Heldeweg & Saintier, 2020).

The need for a low carbon energy system and discussions around just energy access have demanded a change in the established paradigm towards a more decentralized energy structure (Goldthau, 2014; Kendziorski et al., 2021; Schmid et al., 2016). Thereby, it is argued that a decentralized energy transition supports not only the technical change to more renewable energy techniques but also the social change to a more just energy system (Seyfang et al., 2014). The rise of local renewable energy sources, such as solar power, wind, biomass, leads to a higher transmission efficacy, reduction of greenhouse gases and increases co-determination through civil society (Goldthau, 2014; Heldeweg & Saintier, 2020).

Already today, individual and collective citizen initiatives are one of the main drivers in the implementation of decentralized renewable energy sources (Agentur für Erneuerbare Energien, 2021). Within Renewable Energy Communities (RECs), local citizens, and other actors, such as municipalities and small and medium-sized companies, come together to jointly invest and take (co-)ownership in renewable energy (conceptual details in chapter 2.1.1). The electricity generated in this way can be consumed or sold by the members of the community themselves. The establishment of RECs requires resources, like investment capital, knowledge and effort, and the willingness to take risks (Jens Lowitzsch & Hanke, 2019) but when successful, it offers several social and environmental as well as economic benefits (Berka & Creamer, 2018; Brummer, 2018). The transitioning potential of RECs has been promoted by research, citizens, environmental organizations as well as politicians (Bündnis Bürgerenergie e.V., 2020a; Greenpeace Energy, 2020; Gui & MacGill, 2018).

In fact, within the Clean Energy Package for all Europeans, the Renewable Energy Directive (RED II 2018) legally defines and frames the role of RECs as actors in the energy market being able "*to produce, consume, store[, share] and sell renewable energy* (RED II 2018, para. 22,2(a)). It also requires Member States to establish an *"enabling framework"* (RED II 2018, para. 22,4) to support RECs. This includes assessing the capacity, providing access to information and finance as well as capacity building, lowering barriers, and guaranteeing a fair overall process. It specifically demands Member States to ensure that *"the participation in the renewable energy communities is accessible to all consumers, including those in low-income or vulnerable households"* (RED II 2018, para. 4(f)). Germany is currently working on transposing the European directive into national law. Within the National Energy and Climate Plan (NECP), Germany has set the target to reach 30% of the gross energy consumption based on renewable energy by 2030 (65% in electricity, 27% in heating and cooling, 27% in the transport sector)[1]. Thereby, the German strategy explicitly

[1] In 2020, 19.3% of the final gross energy consumption was based on renewable energy; 45.4% in electricity, 15.2% in heating and cooling, 7.3% in transport sector (Umweltbundesamt, 2020).

emphasizes the *"great potential [of RECs] for the successful expansion of renewable energies at national and European level"* (Integrated National Energy and Climate Plan, 2019, p. 74).

The German *Energiewende* (energy transition) has been one of the first decarbonization strategies, which has officially supported citizen-led initiatives early on (Goldthau, 2014). That is also why Germany is one of the countries with higher numbers of community energy initiatives[2] in the EU (see Figure 1-1). So far, financial incentives have been the guiding measure to increase collective renewable energy ownership.

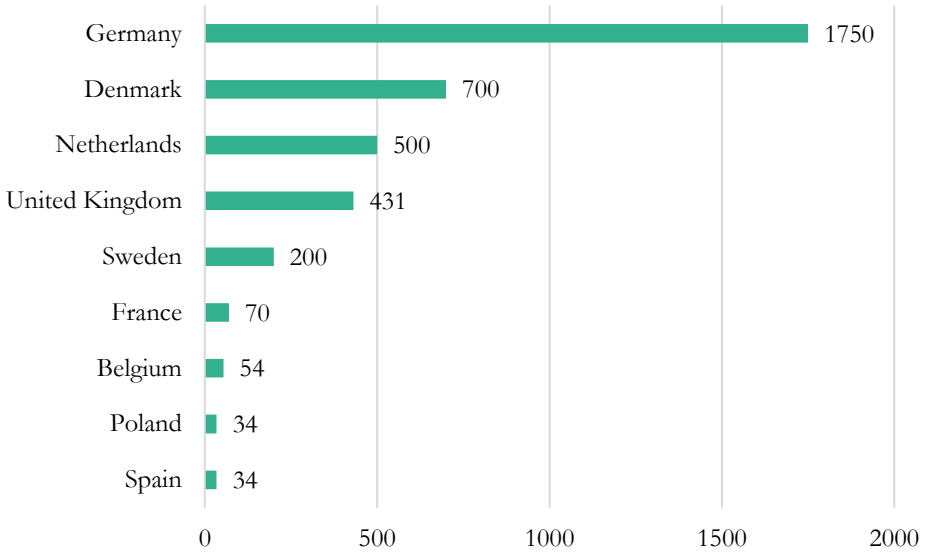

Figure 1-1: Approximate absolute[3] number of community energy initiatives in 2019

Source: Adapted from Caramizaru (2020)

Although Germany's energy transition has increased the number of renewable energy sources effectively, the distribution of its costs has been discussed controversially (Heindl et al., 2014). In fact, Germany has one of the highest energy prices in the EU and although hardly visible, energy poverty is still an issue (Heindl et al., 2014). In 2019, around 289.000 electricity customers failed to pay their bills and had to endure power cut-offs (Bundesnetzagentur, 2021) and even more households must be considered within energy poverty (Bleckmann et al., 2016). Research has found that low-income households bear a higher burden of the energy transition as they spend a higher share of their income on electricity, for example, due to inefficient appliances, and lack possibilities to adapt to higher electricity prices (Diekmann et al., 2016).

Considering intersectionality, female-led, low-income households are at even higher risk regarding their vulnerability to energy poverty (Bleckmann et al., 2016; WECF e.V., 2020). Additional to the gender inequality in energy access, other gender gaps in the energy-related labor market, education as well as in decision-making have been discussed (European Institute for Gender Equality, 2017). Within Germany, women are significantly less represented in the average ownership rate as well as in leadership positions in citizen participation schemes and they invest lower average sums into renewable energy projects (Fraune, 2015). These inequalities

[2] Due to the relatively new legal definition of RECs, it is difficult to say, how many of those initiatives fall under the legal definition or RECs according to RED II.

[3] The absolute number is used as collective energy initiatives can differ in size. Taking the relative number per inhabitants, Germany would follow after Denmark and the Netherlands.

emphasize the required attention towards the social dimension of the energy transition (Radtke & Pannowitsch, 2018).

1.1 Problem definition

Citizens are identified as one of the main drivers of renewable energy technologies. However, while ten years ago the installed renewable energy capacity in Germany owned by citizens used to be higher than 50%, it slowly decreased to around 40% in 2019 (Agentur für Erneuerbare Energien, 2021). With the last changes in the legal framework in Germany, access to stable, economic support for renewable energy ownership became more difficult. In fact, Morris (2019) reported a decrease of newly registered energy cooperatives in Germany since 2014 when auctions were implemented for wind and solar power. Further, several citizen institutions and NGOs have criticized the legal framework in regard to decentralized energy systems and demand the removal of barriers for collective citizen energy (Bündnis Bürgerenergie e.V., 2020a; Greenpeace Energy, 2020).

Local and sustained active and financial participation is necessary for the success of RECs (Bomberg & McEwen, 2012; Kalkbrenner & Roosen, 2016; Ruggiero et al., 2019). To further reach the renewable energy targets, the participation of citizens must be increased (Kendziorski et al., 2021). This raises the question of which strategies, in addition to financial incentives that have been dominating so far, can encourage participation in RECs.

Previous research on the drivers to engage in RECs has shown that participation in RECs is to a large extent motivated through environmental and social reasons. Economic benefits play an additional, minor role (Radtke, 2014). Therefore, it is important to gain a deeper understanding of the determinants of participation in the energy transition (Klöckner, 2013; Steg & Vlek, 2009). Behavioral science gives insights into the decision-making process. Based on the identified determinants influencing behavior, targeted and effective strategies can be designed to increase the motivation to participate (Icek Ajzen, 2006a; Sousa Lourenco et al., 2016; Steg & Vlek, 2009).

The analysis of the willingness to participate gives information about the potential of future RECs and analyzes the determinants of the intended behavior, which increases the understanding of human behavior (Bauwens, 2016). A previous study by Kalkbrenner and Roosen (2016) conducted a survey to empirically investigate the WTP in local renewable energy projects in Germany and find a moderate but positive WTP. The authors highlight the influencing role of social pressure reflected in social norms, which emphasizes the importance of socio-psychological variables regarding the WTP in RECs. Nevertheless, the studies lack a theoretical foundation informing the relationship between social norms and the WTP. Further, no previous research has been conducted on other behavioral aspects, such as attitudes towards participation, personal norms, and the perceived behavioral control over the behavior.

Ajzen and Fishbein (1980) integrate the social norm with the attitude towards, and the perceived behavioral control over, a specific behavior in the Theory of Planned Behavior (TPB). It is based on the assumption that behavior is the product of consciously evaluating the costs and benefits of the specific action (in regard to time, financial resources effort, and social approval). The TPB has previously been extended by the moral component. Based on the Norm-Activation Model (NAM) it is argued that if people feel a strong moral obligation towards a behavior, they are more likely to act that way. The influence of self-interest and moral considerations as socio-psychological determinants have previously been useful in explaining energy-related and other pro-environmental behavior. For instance, it was found that high self-interest and moral obligation, leads to an increase in the adoption of smart energy systems (van der Werff & Steg, 2016), energy activism (Huijts et al., 2013), energy-saving behavior (Abrahamse & Steg, 2009),

recycling intention (Botetzagias et al., 2015), and other pro-environmental behaviors (Harland et al., 1999).

Furthermore, the RED II not only acknowledges the important role of RECs, but also explicitly requires the Member States to ensure a just and inclusive energy transition. However, when looking at the composition of the current members of collective energy initiatives in Germany, the membership is rather homogenous with members of RECs being characterized mostly as male, well-educated, and with high incomes (Poppen, 2015; Radtke, 2014; Yildiz et al., 2015). This lack of diversity leads to the risk of creating a social gap between citizens engaging in RECs and citizens who are simply customers in the energy system bearing potentially higher costs (Caramizaru & Uihlein, 2020). Against the aspiration of RECs to ensure the same access for all citizens, this can create the notion that RECs can reproduce inequalities (Catney et al., 2014; Johnson & Hall, 2014).

Therefore, Caramizaru and Uihlein (2020) recommend that analyzing the barriers and motivations, especially across low-income groups, is critical to advance policies supporting the participation of all households in RECs. Fraune (2015) emphasizes the gender-specific inequalities in the energy transition highlights the need for more research on the social, cultural, and political dynamics as these form the individual's ability to participate. It remains to be seen, the extent to which the influence of socio-psychological determinants of the WTP in RECs differs among income groups and gender.

The current trend of newly registered RECs is decreasing and low-income groups, as well as women, are underrepresented in current RECs in Germany. Therefore, strategies to encourage and enhance the WTP of citizens in Germany in RECs, additionally to financial incentives, must be identified. To develop these strategies, the factors influencing the WTP must first be determined (Steg & Vlek, 2009).

1.2 Research objective

The overall objective of this thesis is to gain an understanding of the socio-psychological factors determining the WTP in RECs. Based on the results of a quantitative online survey of citizens living in Germany, the relationship of self-interest and moral considerations with the WTP in RECs is examined. Special attention is given to differences across income groups and gender.

The literature review, data collection, and analysis are guided by the following three research questions (RQs). The first RQ explores the relationship between self-interest (reflected through the TPB variables attitude, subjective norm, and perceived behavioral control) and the respondent's WTP in REC (For a deeper theoretical and methodological explanation to the specific concepts refer to Chapter 2 and 3.).

RQ1: What influence does self-interest have on the willingness to participate in RECs in Germany?

The second RQ analyzes the relationship between the personal norm and the respondent's WTP in REC and explores if adding the moral component increases the explanatory power additionally to the TPB.

RQ2: Additional to self-interest, what influence do moral considerations have on the willingness to participate in RECs?

Due to the current underrepresentation of low-income groups and women in RECs, particular interest is given to the differences in the socio-psychological determinants and their influence

on the WTP among income groups and gender. Thus, the third RQ examines if differences in the relationship between TPB and the WTP exist.

RQ3: How does the influence on the willingness to participate in RECs differ between income groups and gender?

While the first and second RQs follow a deductive logic to determine whether the following hypotheses (H) apply to the sample, the third RQ is exploratory and inductive.

H1.1: The more positive the attitude towards RECs, the higher the WTP in RECs.

H1.2: The higher the perceived subjective norm, the higher the WTP in RECs.

H1.3: The higher the perceived behavioral control, the higher the WTP in RECs.

H2.1: The higher the personal norm, the higher the WTP in RECs.

It is important to emphasize that it is not the aim to predict the participation in RECs but to understand human behavior by analyzing the determinants of the willingness to participate (Icek Ajzen, 1985). This will help practitioners and politicians in developing contextual and behaviorally informed strategies to increase participation in RECs. The insight into the differences between income groups and gender enables the development of target-specific interventions to broaden participation. This not only allows to advance the energy transition but also enables a just socio-technical transition.

1.3 Scope and (de)limitations

This thesis addresses the knowledge gap on the influence of socio-psychological factors on the willingness to participate in RECs in Germany. Thus, this thesis contributes to the research on citizen participation and inequality in the energy system.

The geographical scope for this study is set within Germany. On the one hand, citizens in Germany have first experience with energy communities and the concept is not completely unknown. On the other hand, the expansion of citizen-led initiatives is further emphasized by the government, and a revision of the legal framework to lower hurdles is demanded by citizen initiatives. This offers the possibility to empirically investigate the topic in a real-life setting (Goldthau, 2014). Further, there have been previous studies highlighting the homogeneity of membership in RECs in Germany, which additionally emphasizes the need for further research to guarantee a just energy transition.

A quantitative online survey is used with the aim of representatively capturing the attitudes of the citizens living in Germany. However, due to limitations in the sampling design and the sample itself, the results are not generalizable to the targeted population but are only valid for the underlying sample (298 participants; see sample characteristics in Section 3.1.1). Nevertheless, the results give a first indication about the relationship between socio-psychological determinants and the WTP, which can be used as a basis for further research. The analytical methods and suggestions on contextual and behaviorally informed strategies might still be valuable for practitioners and researchers in Germany and other parts of the world with similar social and cultural contexts.

A special focus is placed on the difference in behavioral aspects between high, medium, and low-income groups as well as men and women, as these groups are considered vulnerable and are facing inequalities in the energy system, which are currently reproduced in the homogenous membership of RECs in Germany (Hanke & Lowitzsch, 2020; Radtke, 2014). It is important to

understand the differences in socio-psychological factors, to ensure a just energy transition in Germany.

As part of this thesis, the term *Renewable Energy Community* is used in line with the legal definition of the RED II (see Section 2.1.1)., which highlights the narrow scope of local membership. The focus on locality is important, as especially the social benefits (see Section 2.1.3) are stronger if people get together in a close environment. Moreover, the RECs are limited to the most common purpose of renewable energy generation due to the simplicity in explaining it to the target group as part of the survey. As the concept was only recently defined, the literature review is also based on similar terms, such as collective energy initiatives and other energy-related pro-environmental behavior.

A limitation to this study is the restriction in the data collection process due to the COVID-19 lock-down, which limited the empirical data collection possibilities to an online survey. The limitations of the self-administration of the online surveys are discussed in Section 3.1.

1.4 Audience

The main audience of the study at hand are policy makers advancing the energy transition in the policy agenda, practitioners as active actors in the energy transition as well as researchers in the field of citizen participation and energy vulnerability.

On an academic level, it contributes to the current body of knowledge on RECs by investigating the impact of socio-psychological determinants on the WTP in RECs. The direct focus on gender and income groups extends the research on inequality and vulnerability in the energy context.

On the policy level, it mainly addresses local, regional, and national politicians. This emphasis on multi-level governance is important, as cities and regions are having a more and more important and active role within the energy transition next to the more passive, national level, which provides the legal framework (Emelianoff, 2012; Schönberger & Reiche, 2016).

On a practitioner level, the knowledge may be beneficial for RECs themselves, who would like to broaden their membership, as well as for other organizations, like communal housing associations who are interested in setting up communal renewable energy projects. Both parties can derive advice on how citizens, especially low-income households and women, can be better integrated into the RECs through behaviorally informed strategies.

1.5 Ethical considerations

The participation in the online survey was entirely voluntary and under informed consent. The project objective as well as the intended use of the information was openly communicated. A short description of the survey and its use was provided in the beginning so that participants could freely decide to participate or not. Participants were able to withdraw from the survey at any time. The data is only used for the analysis of this thesis using the software STATA 16. The data is stored anonymized on the author's computer. Although contact details can voluntarily be stated, they will be stored separately from the responses and are only used for the lottery of vouchers, which will be raffled among the participants who actively agreed to it. There is no cause to believe that participants may suffer any disadvantage or damage from their participation in the study. The research design has been reviewed against the criteria for research requiring an ethics board review at Lund University and has been found to not require a statement from the ethics committee.

1.6 Disposition

Chapter 1 describes the background and significance of the topic and introduces the defined problem and research objective. It further defines the scope of the research, presents the intended audience, and provides an outline of the thesis.

In Chapter 2, background information regarding RECs, their existence in Germany, and the associated benefits/drivers and costs/barriers of (dis)engaging in RECs are outlined. Then, a socio-psychological perspective on energy citizenship is taken where hypotheses are developed, and a theoretical foundation used for the data collection and analysis is presented.

Chapter 3 described the research design and methods regarding data collection and data analysis.

Chapter 4 presents the main findings of the data analysis and concludes with hypothesis testing.

In Chapter 5, the relevance of the findings is discussed concerning previous literature. Then, policy implications are discussed, and limitations of the methodology are reviewed.

Chapter 6 presents the main conclusions of the work and provides recommendations directed to the targeted audience. This final section concludes with areas of future research.

2 Conceptual framework

This chapter first gives background information on the concept of RECs (2.1). It introduces its legal definition and typologies, describes the situation in Germany, and presents the benefits and costs of participation in RECs, which have so far been identified in the literature.

It then (2.2) introduces the theoretical foundation to understand the socio-psychological influence on the WTP in RECs. Further, the current state of the literature on the determinants of participation in the energy transition is discussed. The literature is based on both German and international literature in order to gain a comprehensive understanding of the current state of research.

2.1 Renewable Energy Communities

2.1.1 Definition and typology

When addressing citizens' participation in a collective energy action, it is often referred to as the concept of community energy or energy communities. Although slightly different in meaning, these terms are often used inconsistently in the literature due to a lack of a common definition (Gui & MacGill, 2018). While the former generally refers to collective citizen participation in the energy sector (Gui & MacGill, 2018), the latter *"can be understood as a way to 'organise' collective energy actions around open, democratic participation and governance and the provision of benefits for the members or the local community*"(Caramizaru & Uihlein, 2020, p. 4).

It is important to mention that energy communities are not a new phenomenon. In particular, remote places and islands have been dependent on community renewable energy projects to secure affordable and constant energy availability (Rae & Bradley, 2012). However, in light of the energy transition, decentralization and the role of community energy initiatives have become more and more important (J Lowitzsch et al., 2020). The societal attention, as well as action towards energy issues and self-sufficiency, have started with the environmental movement and energy crisis in the 1960s and 1970s. With the mainstreaming of renewable energy and financial policy support instruments, community energy projects were established in certain counties. Then again, with the Great Recession in 2008, the increasing energy prices, a weak economy, and a centralized energy system dominated by global firms raised the attention again towards issues, like energy democracy and citizenship through community energy initiatives (Hewitt et al., 2019).

Until recently, energy communities have not been clearly defined. Only with the Clean Energy Package for all Europeans (CEEP), a definition of the term *Renewable Energy Communities* was provided. The RED II (2018, para. Art 2,16) defines RECs as follows:

> *renewable energy community' means a legal entity*
>
> *(a) which, in accordance with the applicable national law, is based on open and voluntary participation, is autonomous, and is effectively controlled by shareholders or members that are located in the proximity of the renewable energy projects that are owned and developed by that legal entity;*
> *(b) the shareholders or members of which are natural persons, SMEs or local authorities, including municipalities;*
> *(c) the primary purpose of which is to provide environmental, economic or social community benefit*

Additionally, the Internal Electricity Market Directive (IEMD 2019)defines a similar concept, Citizen Energy Communities, which sets the focus on energy communities in general instead of

renewable energy and differs in the interpretation of membership and control as it is open to all entities independent of proximity. While the RED II aims to provide support, the IMED encourages a level playing field against incumbent players in the centralized energy system (bridge Horizon 2020, 2019).

Although community energy projects are often referred to as a homogenous phenomenon in the literature and practice, the concept is heterogeneous in several ways (Seyfang et al., 2013). Table 2-1 summarizes the main characteristics of RECs according to the RED II.

Table 2-1: Main characteristics of RECs according to RED II

Criteria	Renewable Energy Communities
Energy sector	Renewable energy market (heat and electricity)
Legal form	Not defined (e.g., limited partnership, cooperative, trusted scheme, …)
Eligibility	• Open and voluntary • Actors: Natural persons; Small and medium-sized enterprises; Local authorities, incl. municipalities
Ownership and Governance	• Effective control by shareholders or members that are located in the *proximity* of the renewable energy project • Autonomous (no individual shareholder may own more than 33% stock)
Activities	Generation, distribution, consumption, storage, sale, aggregation, supply, and sharing of renewable energy; Energy-related services (commercial
Purpose	Environmental, social, and economic benefits for society

Source: Adapted and modified from bridge Horizon 2020 (2019) *and Lowitzsch (2020)*

The **legal form** influences how an energy community is organized and owned. The RED II does not define a certain legal form as different situations require different governance models. The form of limited partnerships and cooperatives needs a strong bottom-up initiative through citizens. Limited partnerships (GmbH & Co. KG) are often used in regard to higher investment projects, such as collective wind parks (Caramizaru & Uihlein, 2020). A trusted scheme is based on a trusteeship, which includes a fiduciary facilitating shareholding through individual customers. Additionally, there are other top-down legal structures in which local municipalities take an initiating role, such as public-private partnerships and public utility companies (Interreg, 2018). The advantage of such forms is that the financial risk is mitigated by the public authorities that initiate the projects (Hewitt et al., 2019). However, public participation is not necessarily part of it and therefore *"needs to be designed in, not assumed-in"* (Lowndes & Sullivan, 2004, p. 51).

The eligibility of different actors in RECs can vary among natural persons, small and medium-sized enterprises as well as local authorities that do not participate in the energy sector as their primary economic activity. The inclusion of vulnerable and low-income households, as well as the role of public authorities, is specifically addressed in the RED II (2018, paras. 22, 4(f) and (h)).The eligibility of RECs can vary depending on the requirements of participation (e.g., local geographical scope). The participation is mostly bound to the purchase of shares, which commonly varies between 50 and 500 EUR. This financial burden is especially high for low-income households, who might not have the financial means to participate (bridge Horizon 2020, 2019). The ownership is based on two main principles. The *effective control* is restricted to

the members or shareholders in the proximity[4] of the energy project and thus emphasizes the local benefits (bridge Horizon 2020, 2019). The *autonomy* of RECs stresses the collective will through the independence of external actors (bridge Horizon 2020, 2019). While differences in financial means are balanced through concepts like "one member – one vote" or shareholder caps, differences in knowledge can be equalized through training and capacity-buildings (bridge Horizon 2020, 2019).

Rather than representing a certain **activity** around local energy systems, RECs represent the way to organize it. Although energy generation is mostly the primary activity of RECs, other activities are energy supply, consumption, aggregation, energy sharing, distribution, and eventually other energy as well as electro-mobility services (for a detailed description see bridge Horizon (2019, p. 37ff)). The focus on an energy technology can vary among renewable heat and electricity energy sources, such as wind, solar, small hydro, bioenergy technologies, combined heat and power plants, heat pumps, district heating networks, or electric vehicles (Caramizaru & Uihlein, 2020).

2.1.2 Renewable Energy Communities in Germany

At the end of the 19th century, as large energy companies did not expand their grid to remote places due to a lack of profitability, cooperatives in the energy sector were formed to secure a stable energy supply in rural areas. However, the expansion of centralized coal, gas, and nuclear energy led to a significant decrease in the middle of the 20th century (Yildiz, 2014). With the anti-nuclear movement in the 1970s, collective energy initiatives in form of cooperatives and other legal forms have been starting to reemerge to advance the decentralization of energy production (Yildiz, 2014). Especially between 2000 and 2013, there was an increase in the number of cooperatives and other legal forms (Radtke, 2016). Today, as seen in Chapter 1, Germany is one of the European countries with higher numbers of collective energy initiatives. Numbers from 2016 suggest that around 42% of the renewable energy produced in Germany is due to individual and collective citizens' initiatives (Bündnis Bürgerenergie e.V., 2019). The main legal form of RECs is an energy cooperative, followed by limited partnerships (Holstenkamp et al., 2018). In fact, there are around 835 energy cooperatives with 20.000 members (DGRV, n.d.). The great majority of the citizen-led energy initiatives are located in the former western part of Germany.

The example box in Figure 2-1 gives several examples of successful collective energy initiatives in Germany. As they were established before the RED II, some may not fully correspond with the definition of RECs. For instance, the *EWS Elekrizitätswerke Schönau eG* distributes electricity all over Germany and is thus not considered under the RED II definition but serves as a good example of a collective energy initiative.

[4] The interpretation of "proximity" can vary among Member States (bridge Horizon 2020, 2019)

The **BürgerEnergie Berlin eG** is a citizen cooperative in the capital city of Germany founded in 2011. It produces green electricity by collectively financing, managing, and installing the setup of a photovoltaic power plant. As part of the remunicipalization, Berlin is buying the electricity grid back from the current owner and electricity company Vattenfall in 2021. The cooperative would like to use this chance to participate in this undertaking to support an innovative, renewable grid operation in the future.[5]

The **EWS Elekrizitätswerke Schönau eG** is a citizen initiative established in 2009. In 2019, the cooperative counted 8277 members and has four subsidiaries covering the services for a decentralized and renewable energy supply, ranging from energy sales, network operation, and energy services to the construction of renewable energy generation plants and heating networks (Solar power, combined heat and power, and wind plant) and cooperation.[6]

The **Heidelberger Energiegenossenschaft** was founded in 2010 based on a student initiative, which implemented solar panels on the university building. Today, the cooperative counts 1500 members and engages in the generation of solar and wind energy. They have several projects focusing on tenant electricity and work in cooperation with building cooperatives.[7]

The **Windpark Druiberg GmbH & Co. KG** is a limited partnership in Dardesheim and has been installing wind turbines since the 1990s. With a capacity of 82,6 MW, it produces more than 40 times the yearly demand of the small village. The ownership is limited to local citizens. 90% of the residents are involved in the project (Roberts et al., 2014).[8]

Figure 2-1: Example Box: Collective energy initiatives

Several policy drivers were identified that led to the distribution of RECs in Germany.

Policy drivers

The *Energiewende* combines efforts to decrease the dependency on nuclear power and fossil fuels while increasing the energy efficiency and the number of renewable energy sources to decarbonize the energy-economy system in Germany (Sonnenschein & Hennicke, 2015). The central legislation supporting the phase-out of fossil and nuclear fuels is the *Erneuerbare Energien Gesetz* (EEG) (English: Renewable Energy Act) (Sonnenschein & Hennicke, 2015). First introduced in 1991 as the *Stromeinspeisungsgesetz* (English: Electricity Feed-in Act), it regulates the feeding-in of renewable energy into the grid (Schreuer, 2012). The EEG came into force in 2000 after a revision and improvement of the concept of feed-in-tariffs (FIT). Since then, the law has been amended several times. FITs are one of the major financial policy instruments with the aim to increase the share of renewable energy sources, promote technological advancement through enhanced development and economy of scale and, in turn, decrease the generation expenses for an individual technology (Mendonça Miguel et al., 2009). It enables citizens and smaller private and public actors to invest individually and collectively in certain types of renewable energy technologies under secure and long-term conditions (Brummer, 2018). The

[5] https://www.buerger-energie-berlin.de/

[6] https://www.ews-schoenau.de/

[7] https://heidelberger-energiegenossenschaft.de/

[8] https://energiepark-druiberg.de/geschichte-energiepark/wir-ueber-uns/

guaranteed tariff, grid priority of renewable energy, and long-term purchase agreements reduce the risk of investment significantly (International Energy Agency (IEA), 2008). The FITs achieved a significant expansion of renewable energy sources, especially solar, wind, biomass, and geothermal, and supported the development of RECs (Caramizaru & Uihlein, 2020). The costs are distributed through a surcharge (German: *EEG-Umlage*) to the final consumers by adding it to the electricity bill, which led to a comparable high electricity price in Germany (Mendonça Miguel et al., 2009).

The gradual transition to a market-based renewable electricity supply independent of financial government support started in 2014 and 2016 when feed-in-tariffs were altered to a market premium model (a premium is added to the market price (Couture & Gagnon, 2010)) with direct marketing for electricity produced at facilities with a capacity of more than 100 kW (BMWi 2017). Additionally, an auction system for the financial funding of a new renewable energy facility was implemented. The resulting higher costs, complexity, and risk increased the barrier for individual and collective energy initiatives, which led to a drastic decrease of newly registered RECs (Morris, 2019). With the amendment of 2021, certain exceptions were, for example, for photovoltaic plants with a capacity lower than 750 kW (Bündnis Bürgerenergie e.V., 2020a).

Additional to the regulatory framework, the state-owned bank KfW has been providing low-finance loans and refinancing options to guarantee a stable financial basis (Bauwens et al., 2016; Oteman et al., 2014). Although the economic instruments provide low-risk investment conditions, they are mostly targeted to households with moderate or high income as a high initial investment is necessary, which leaves low-income households neglected (Hanke & Lowitzsch, 2020).

Already before the CEEP, in 2017, the EEG established a legal framework for *Bürgerenergiegesellschaften* (Citizens' Energy Companies), which now needs to be adapted to the European RED II (bridge Horizon 2020, 2019). According to the NECP (2019), the German government is assessing the need for changes to comply with the RED II on the European level. The EEG defines the legal framework of Citizens' Energy Companies, which are linked to wind energy only and require a minimum of 10 natural persons. To guarantee effective control through the citizens and autonomy, 51% of the voting rights must be in hands of citizens, who live in the district of the energy project. The amount of voting rights each actor can hold is restricted to 10%.[9] Paragraph 36(g) warrants privileges for citizens' energy companies in the renewable auctions (bridge Horizon 2020, 2019). However, the legal definition has been criticized from several perspectives as, in combination with the exception regulation, it did not increase the stakeholder diversity but instead provided loopholes for bigger companies to win the auctions (BBEn & DGRV, 2019). Several citizen-led institutions suggested an alternative definition with adjustments to emphasize local responsibilities and social benefits. Suggestions included the expansion of the definition for citizens to any proximity within 25 km surrounding, a minimum of 60% of equity and voting rights in the hands of local citizens, and a total of a minimum of 50 natural persons (BBEn & DGRV, 2019).

Since 2017, the *Mieterstromgesetz* (tenant electricity law) further decentralizes the energy supply in urban areas, by offering financial benefits to landlords or other operators of photovoltaic plants on residential buildings. It improves the possibilities for tenants to contribute locally to the energy transition by using the green electricity produced within the building (BMWi, 2017). Since the amendment of the EEG in 2021, the conditions for tenant electricity in the context of photovoltaic systems were further improved through an increase in the tenant electricity

[9] EEG 2021, para. 3, sec. 15

surcharge, the exemption of taxes and levies, and a neighborhood approach was introduced, which broadens the eligibility for the electricity consumption (Götz Peter (Genossenschaftsverband e. V.), 2021). In the context of RECs, the energy cooperative *BürgerEnergie Berlin* uses tenant electricity to advance the energy transition in the city.

The legal framework has been criticized by several actors for the lack of support for collective citizen' initiatives and several legal and bureaucratic hurdles (Bündnis Bürgerenergie e.V., 2020a). The main critique is, that collective citizen initiatives are not considered under the privileges of self-supply. Since 2017, the self-supply offers a possibility for citizens to reduce the surcharge payment by consuming the own electricity. With the amendment in 2021, the self-supply privilege, meaning the exception of the levy for self-supply, was increased for facilities from 10 kW to 30 kW (in line with the RED II). Facilities over 30 kW still partially need to pay the surcharge (Bündnis Bürgerenergie e.V., 2020a). However, this privilege only accounts for individual presumption under three requirements: the producer and consumer are the same person, no public grid is used for transmission and it is in close proximity. From the citizen perspective, criticism was raised that this requirement prohibits the direct energy supply to REC members (Bündnis Bürgerenergie e.V., 2020a; Götz Peter (Genossenschaftsverband e. V.), 2021). Instead, it demands RECs to sell the electricity and buy it back more expensively from the market, which increases efforts in billing, measuring and other organizational duties. The government was called to assess the potential of energy sharing for RECs in order to align with the RED II until June 2021 (Bündnis Bürgerenergie e.V., 2020b).

2.1.3 Benefits and drivers

There are several economic, environmental, and social benefits incentivizing as well as costs hindering the participation in RECs on an individual and societal level. It is important to mention though that community rather than personal benefits lead to sustained involvement in community energy initiatives (Hoffman & High-Pippert, 2010).

Economic benefits

There are several economic benefits, such as local value creation and employment opportunities within the community results of RECs (Berka & Creamer, 2018). The local economy can benefit through the local generation of jobs - directly by keeping the construction, operation, and maintenance of the system locally and indirectly by fostering the local supply chain through local procurement (Li et al., 2013; Walker, 2008). Thus, the financial resources are kept within the region. For instance, *EWS Schönau* employs around 110 local citizens and as an owner of the local distribution grid, it mandates local companies for the grid maintenance (bridge Horizon 2020, 2019). Moreover, medium to large-scale RECs can generate financial benefits through reduced electricity bills or annual dividends. These gains can be distributed among the participants or be reinvested in local community projects (Berka & Creamer, 2018; Caramizaru & Uihlein, 2020). By way of example, Okkonen and Lehtonen (2016) apply an input-output model to community wind projects in North Scotland and find socio-economic benefits of reinvesting profit in social projects.

Social and environmental benefits

Increasing research has been focusing on the social innovation potential of energy communities as a change of social practice to enhance societal well-being (Hewitt et al., 2019). In a study on community participation in wind power in Japan, Maruyama et al. (2007) refer to the socio-economic dynamics through renewable energy technologies that *"changes the rule of risk-benefit distribution and the roles of social actors"* (Maruyama et al., 2007, p. 2761). In fact, energy communities are discussed in regard to fostering energy democracy, whereby citizens become recipients, stakeholders, and accountholders of the energy system (Szulecki, 2018). The co-ownership of

renewable energy projects empowers the owners to exercise control over the local energy projects and their process (J. J. Park, 2012). In line with this procedural energy justice, Walker and Devine-Wright (2008) emphasize the potential of distributional energy justice meaning the distribution of benefits. Instead of big, centralized energy companies skimming off profit, the fair distribution of profits is commonly agreed on by members. It is important to emphasize though, that energy justice is only fulfilled if everyone has the same access to becoming a co-owner (Caramizaru & Uihlein, 2020).

Moreover, with the local co-ownership and governance of RECs, citizens can reclaim control over the energy system (Hicks & Ison, 2018). The extent to which shareholders or members influence the decision-making can depend on the legal form used (see Table 2-2).

Table 2-2: Decision-making in different legal forms of energy communities

	Limited Partnership	Cooperative	Trusted Scheme
Influence on decision-making	Right to demand information; control and veto rights for consumer-shareholders only under exceptional circumstances	Direct: "one member one vote"; general assembly concentrates decision-making power	Indirect: Trustee exercises rights for consumer-shareholders, e.g., participation in management meetings or the right to demand information

Source: Adapted and modified from Hanke and Lowitzsch (2020) *and Lowitzsch and Hanke* (2019)

Central to the social benefits is also the (re)production of social capital (Berka & Creamer, 2018). Collective energy production increases community building and social cohesion by creating a community spirit and trust (Caramizaru & Uihlein, 2020). However, Walker and Devine-Wright (2010) show with case studies in the UK that community identity and trust can also erode due to conflicts. Additionally, collective energy initiatives are discussed as a mechanism to empower vulnerable households to alleviate energy poverty by opening access to affordable energy and increasing energy efficacy (Jens Lowitzsch & Hanke, 2019). This is especially important for remote places where energy costs are high. Hanke and Lowitzsch (2020) specifically emphasize the benefiting potential of a new socio-cultural surrounding for vulnerable households to overcome systemic barriers, like unemployment and low education.

Another main social benefit is the increased acceptance of renewable energy projects. Democratic deficits and unjust distribution of advantages and disadvantages have often led to a low acceptance of renewable energy infrastructure projects (Bell et al., 2013). Especially for windmills, the debate is often referred to as NIMBY (not-in-my-backyard) (Devine-Wright, 2008). Instead, collective participation through RECs increases the public acceptance of renewable energy projects. Musall and Kuik (2011) empirically tested the influence of community ownership on the local acceptance of wind energy as part of a case study in the southeast of Germany. The author finds that community co-ownership leads to a higher acceptance of local wind turbines and a more positive attitude towards wind energy in general. Similar results are found for a case study from southwest Scotland (Warren & McFadyen, 2010).

Further, the increased awareness and knowledge about renewable energy as well as skills (e.g. project management, leadership, project financing, etc.) are important social benefits of RECs (Berka & Creamer, 2018). The enhanced awareness and knowledge about renewable energy through self-generation eventually influence consumption behavior (Roth et al., 2018). In fact, as part of the REScoop Plus project, it was found that members of energy cooperatives tend to consume less energy (Sifakis et al., 2019). Nevertheless, the study of Gupta and Barnfield (Gupta & Barnfield, 2013) on low carbon communities in the UK warns of unintended negative behavioral effects increasing the energy consumption if the environmental mission statement is

not inherent in the project (Berka & Creamer, 2018). Regarding the environmental benefits, the increase in energy efficacy through improved awareness and knowledge as well as a decentralization through higher acceptance of local renewable energy leads to a reduction of air pollution (bridge Horizon 2020, 2019).

Berka and Creamer (2018) emphasize that for many of these social advantages an inclusive and active engagement is necessary. Martiskainen (2017) finds that active participation is a prerequisite of learning, such as leaders who invest a lot of time and effort in understanding processes and building expertise. Therefore, an increase in social benefits is dependent on an early, effective, and broad engagement of the community. Additionally, the findings from Radtke (2014) regarding the homogeneity of membership limits the diffusion of the social and economic benefits, currently excluding mainly women and low-income households.

Drivers

Analyzing the individual and community motivations and benefits helps to understand the past and future development of RECs (Verde & Rossetto, 2020). In general, the most common motivations can be grouped into environmental, economic, and social (Seyfang et al., 2013) as well as technological and political motivations (Hicks & Ison, 2018). Motivations are often diverse and can be influenced through contextual factors, such as time, technology, legal governance form, region, level of investment, function in the initiative (Holstenkamp & Kahla, 2016).

Several studies conclude that reduced energy costs and air pollution, renewable energy development, local ownership, and decision-making are prevailing motivations (Hicks & Ison, 2018; Radtke, 2014; Seyfang et al., 2013). Differences among the studies exist in what the dominating factor is. Radtke (2014) finds based on a survey among community energy initiatives in Germany, that 93% of the respondents choose ecological reasons as their primary reason; 56% also indicate economic reasons. Several studies find that economic motivations increase with the investment size (Holstenkamp & Kahla, 2016; Radtke, 2014). Although individuals in the Netherlands stated that financial motives are most important, the authors find that environmental and communal motives influence participation, which leads to the conclusion that communal factors are underrated (Sloot et al., 2019).

2.1.4 Costs and barriers

Although various benefits of RECs exist, there are also several barriers when it comes to citizen participation (Bomberg & McEwen, 2012; Brummer, 2018). One of the barriers identified most often is the lack of resources. Although RECs have several financial benefits as discussed earlier, the high-risk cost during the planning phase and the initial investments pose challenges (Oteman et al., 2014; Radtke, 2014; Yildiz et al., 2015). Although risks can be reduced through government grants and social investment funds, financial challenges often remain. Additional to the lack of financial resources, citizens might face challenges due to the lack of time (Koirala et al., 2018) as well as, the lack of essential awareness, knowledge, and skills (Rogers et al., 2008). Explicitly for Germany, Brummer (2018) emphasizes the dependency on volunteers, especially when the cooperative is a common legal form.

In fact, the barriers are often connected with the organizational and governance form (Brummer, 2018). Depending on the legal form, different entry barriers through equity contributions, knowledge and time commitment as well as risks exist (Jens Lowitzsch & Hanke, 2019). Table 2-3 shows a comparison of some bottom-up legal structures.

Table 2-3: Different legal structures of energy communities

	Limited Partnership	Cooperative	Trusted Scheme
Equity contribution	Moderate; access to credit only against collateral or with guarantor	Moderate; membership shares have to be bought requiring liquidity	Low; future earning are used to repay acquisition loan
Basic knowledge	Medium; Managing partners external management possible	High; setup and management by members; no eternal management	Low; setup and supervision by a trustee; external management possible
Time commitment	Low; involvement limited to control rights	Medium; members expected to be involved in all aspects	Low; involvement limited to crucial decision; apprenticeship over time
Risk	Low; liability limited to value of share	Low; liability limited to value of share	Low; liability limited to value of share

Source: Adapted and modified from Hanke and Lowitzsch (2020) *and Lowitzsch and Hanke* (2019)

Other challenges are the legal, regulatory barriers, meaning the lack of stable organizational and legal frameworks which consistently support decentralization and provide financial incentives (Yildiz, 2014). The lack of community trust and shared identity, as well as a high-risk aversion, lead to social and psychological barriers (Herbes et al., 2017; Kalkbrenner & Roosen, 2016; Koirala et al., 2018).

2.2 Socio-psychological approach to energy citizenship

There is a growing academic interest in linking behavioral science with socially and environmentally driven actions. Specifically, the goal is to gain a better understanding of the decision-making process concerning human behavior that has an impact on the environment (Gardner & Stern, 1996). These *„environmentally significant behaviors"* (Stern, 2000, p. 408) include, for example, environmental activism, citizenship, consumer purchase behavior, and waste disposal behaviors. By understanding how behavior is formed through various factors, behavioral interventions can be designed to alter or lower the environmental impact of decisions. In the context of energy research, Sovacool et al. (2015) argue that integrating social sciences increases the understanding of sources and dynamics of energy challenges and allows to develop interventions.

The concept of energy citizenship is understood as "*view of the public that emphasizes awareness of responsibility for climate change, equity and justice in relation to […] the potential for (collective) energy actions, including acts of consumption and the setting up of community renewable energy projects such as energy co-operatives* (Devine-Wright, 2007, p. 72). More specifically, the concept characterizes social and public actors as active stakeholders taking responsibility to increase justice in the energy system (Devine-Wright, 2007).

Several successful citizen energy projects have shown, that the establishment of energy communities relies vastly on energy citizenship (Cederquist Andrea et al., 2020). Different degrees of involvement exist and can range from passive, financial participation to more active participation in planning, operationalizing, and managing the project (Devine-Wright, 2008; Kalkbrenner & Roosen, 2016). Based on the motivations of members of existing RECs in Germany, Radtke (2014) identified three types of participation. The *cultural and social participation* takes place during events, *political and organizational participation* addresses the contribution to co-

determination decision-making, as well as the *financial and economic participation* as monetary contribution through for example shares.

There are different disciplinary perspectives and approaches to decision-making in the social sciences (Wilson & Dowlatabadi, 2007). Conventional economics has long been the dominant model, explaining decision making with utility maximation assuming full rational individuals focusing on short-term benefits. However, the criticism against this traditional idea is manifold. The concept of *bounded rationality* acknowledges the discrepancy between perfect rationality and human behavior and criticizes the assumption of purely rational choices (Simon, 1990). Jackson (2005) summarized three main issues. Firstly, humans are facing cognitive limitations when deciding on behavior and therefore rely on cognitive short-cuts, such as routines, cues, and heuristics. Secondly, the rational decision-making of humans lacks to address the social context, in which actors are embedded, which can include affective and emotional responses. Thirdly, rational choice fails to include moral considerations. Schwartz (1984) emphasizes that behavior is not only the result of self-interest but also altruistic reasons. Thus, behavioral science instead acknowledges bounded rationality and concludes that decisions depend on different heuristics and contextual factors. The socio-psychological approach suggests the interactive influence of contextual and psychological factors (Devine-Wright, 2007; Wilson & Dowlatabadi, 2007).

There are several behavioral theories, explaining pro-environmental behavior (for a more extensive list, see Jackson (2005)). There are theories, such as the Theory of Reasoned Action (Fishbein M & Ajzen Icek, 1975) and the TPB (Icek Ajzen, 1991), for which attitudes and subjective norms are central. Instead, the NAM (Schwartz, 1968, 1977) and the VBN (Stern et al., 1999) set personal norms in the focus of decision-making. In the following, the TPB, NAM, and VBN are described, which serve as a basis for this research.

2.2.1 Theory of Planned Behavior

The TPB (Icek Ajzen, 1991) is one of the most common theoretical concepts to explain the behavior of humans in certain contexts and has been successfully applied to pro-environmental behavior. The TPB is an extended theory of the Theory of Reasoned Action (I Ajzen & Fishbein, 1980). The individual's intention to behave is central to this model and represents the antecedent of the actual behavior.

The theory suggests that human intention to behave can be predicted through beliefs, which act as antecedents of the three main determinants: attitude, subjective norms, and perceived behavioral control (see Figure 2-2). It assumes that with increasing favorable attitude, subjective norm, and perceived behavioral control, the individual's intention for a certain behavior enhances. The relative impact of the three determinants can vary across contexts (Icek Ajzen, 2005). Further, the TPB assumes that socio-demographics have an indirect influence on the intention to behave as they are reflected in the main psychological constructs (I Ajzen & Fishbein, 1980). Although the intention to behave and the actual behavior are closely related, its translation is further dependent on other contextual factors (Stern, 2000).

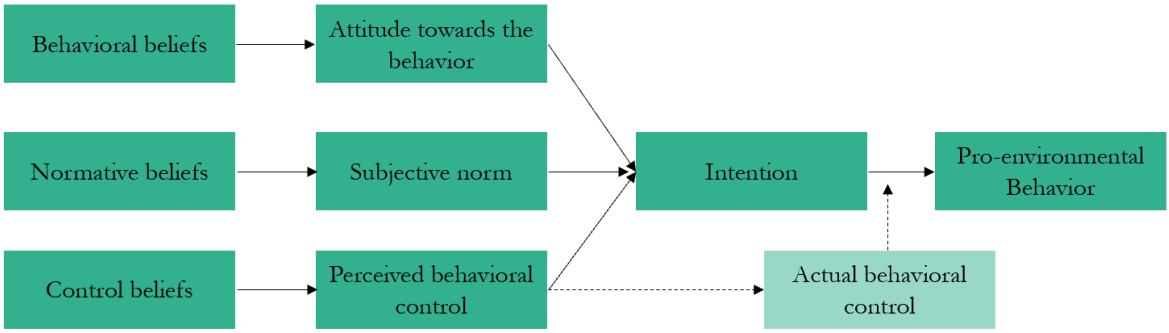

Figure 2-2: Theory of planned behavior

Source: Adapted from Ajzen et al. (2018)

Attitudes

Based on Fishbein and Ajzen's (1975) expectancy-value model of attitudes, *behavioral beliefs,* which result out of the evaluation of attributes (such as costs and benefits), impact the attitude towards a behavior. The *attitude* describes to what extent a person evaluates the performance of the behavior as positive or negative. For instance, Abrahamse and Steg (2011) have found that the attitude toward energy conservation and the perceived behavioral control increase the intention to reduce energy in the household.

Subjective Norms

Social norms *"provide people with decisional shortcuts of how to behave in certain situations"* (Stok & de Ridder, 2019, p. 1). Thereby, confirmation and recognition through peers can motivate a certain action (Mignon & Bergek, 2016). In general, there are two types of social norms. According to the theory of normative conduct, the *descriptive social norms* refer to what is typical or normal and the *injunctive social norms* (subjective norm) refer to what is appropriate or desired ("ought to be") (Cialdini et al., 1990).

According to the TPB, the extent to which important individuals and groups judge the behavior favorably is captured in the *normative beliefs*, which influence the *subjective norms*. This concept aligns with the (injunctive) social norm of the theory of normative conduct, which indicates the perceived social pressure to behave in a certain way. This means that *"(w)hen people believe that most respected others would expect them to perform the behavior or are themselves performing the behavior, the subjective norm will exert pressure to engage in the behavior"* (Icek Ajzen et al., 2018, p. 53).

Within the research on renewable energy, the social pressure through peers captured in subjective norms has raised the interest of several researchers. The importance of subjective norms has previously been highlighted in different contexts. By way of example, studies have analyzed the normative impact of peer effects regarding the adoption of photovoltaic plants (Bollinger & Gillingham, 2012; Noll et al., 2014) and investments into renewable electricity production (Mignon & Bergek, 2016). Kalkbrenner and Roosen (2016) revealed the significant influence of social norms regarding the WTP in collective renewable energy projects in Germany. Bauwens (2016) underlines the importance of norm-driven behavior especially for locally bound communities due to personal interactions.

Perceived behavioral control

The TPB further suggests that the attitude and subjective norm only have an influence when a person is believed to have control over the action (Icek Ajzen, 1991). The degree to which the individual perceives to have control over the behavior or not is captured in the *control beliefs*. The *perceived behavioral control* refers to the perceived degree of control to behave in a certain way. Although Ajzen (Icek Ajzen, 1991) compares the perceived behavioral control with the self-efficacy concept of Bandura (1986), which reflects the cognitive control perception based on personal capabilities, it is important to emphasize that perceived behavioral control can be shaped by both, internal and external factors.

On the one side, **external factors** can determine how much control one perceives over the behavior. An action is perceived as easy to perform when there are no external factors posing hurdles for a behavior (Kidwell, 2003). Stern (2000) emphasizes contextual factors regarding pro-environmental behavior. Among others, this includes energy policy regulations, and incentives, as well as socio-cultural aspects (Stern, 2000).

Several aspects of energy policy have been highlighted regarding the success of energy communities (Ruggiero et al., 2019). For example, energy prices can both drive and impede the development of RECs. While high energy prices were discovered to be a major driving force in the development of RECs in Northern European countries, low energy prices can hinder investment (Ruggiero et al., 2014). The type and level of supportive measures are critical in encouraging REC participation. For instance, the role of feed-in-tariffs, grants and loan schemes, and tax incentives were highlighted (see Curtin et al., 2017).

Moreover, the willingness to participate in collective energy projects is influenced by various socio-cultural factors. Previous empirical studies have shown that community trust directly influences and that community identity indirectly influences the WTP in a community energy project (Kalkbrenner & Roosen, 2016; Koirala et al., 2018). The importance of trust and social capital has also been highlighted by Walker et al. (2010). A sense of community stimulates action and collaboration through a high degree of solidarity between citizens (Bomberg & McEwen, 2012). Social identity appears to be also important concerning other community-based pro-environmental initiatives (Bamberg et al., 2015). Further, the culture and societal attitude towards cooperative enterprises have been mentioned as a success factor for community energy in Germany (Bauwens et al., 2016).

On the other side, **internal factors** can determine the degree of perceived behavioral control through self-efficacy, meaning the perceived personal capabilities. Internal control is high when an individual is perceived to have control over their resources (Kidwell, 2003). Personal capabilities include knowledge and skill, time as well as other resources, such as literacy, money, social prestige, which are necessary to perform a specific activity. The capabilities are reflected in socio-demographic and economic variables, such as gender, education, and income, and are commonly used as proxies (Stern, 2000).

The previously elaborated requirements, such as time, skills, and knowledge as well as financial resources suggest that the WTP is dependent on socio-demographic and economic factors. In line with this assumption, Radtke (2014) highlights that the membership of existing RECs is dominated by male, well-educated, high-income, and middle-aged citizens. Kalkbrenner and Roosen (2016) find that the WTP in local renewable energy projects increases with income. Instead, Koirala et al. (2018) did not find a significant influence of income on the willingness to participate in community energy systems. The influence of income has been analyzed previously in regard to other pro-environmental energy behaviors. By way of example, the participation in green electricity programs (Clark et al., 2003) and the willingness to pay for green electricity

(Zorić & Hrovatin, 2012) increases with higher incomes. The positive influence of income resonates with the study of Sardianou and Genoudi (2013) who find a higher willingness to adopt renewable energy technologies with increasing income. It also corresponds with findings concerning volunteering in environmental organizations, which indicate that the middle and upper class have a higher willingness to volunteer than the lower economic class (García-Valiñas et al., 2012).

Further, previous research found that the WTP in local renewable energy projects is higher for men than for women (Kalkbrenner & Roosen, 2016). The dominance of men contradicts previous studies regarding general pro-environmental behavior, which found that women are more likely to behave in an environmentally friendly way due to stronger beliefs in the negative implications of bad environmental conditions (Stern et al., 1993; Zelezny et al., 2000). However, it aligns with previous research proving an overrepresentation of men in citizen participation in explicitly renewable energy projects (financial investment, decision-making, managerial tasks). It is argued that this gender inequality is influenced through underlying social, cultural, and political contexts, which shape the *"individual's agency and capabilities to participate"* (Fraune, 2015, p. 65), such as the gender wealth gap and occupational segregation. Among others, potential reasons for this gender inequality in the renewable energy sector are patriarchal structures, including traditional roles and thinking patterns, male dominance and an underrepresentation of women among the energy sector, as well as a lower awareness of energy-specific networks due to a lack of time, money and technical disinterest (WECF e.V., 2020).

Literacy and behavior-specific knowledge and skills additionally influence pro-environmental behavior (Stern, 2000). Regarding the success of energy communities, Ruggiero (2019) emphasizes the following three characteristics of actors: leadership, mindset, and commitment. Leaders of community energy projects need tacit knowledge, such as networking skills, to gather resources for a project (Martiskainen, 2017). At the example of the island Samsø in Denmark, Sperling (2017) showed that the entrepreneurial mentality of the actors is crucial to stimulate initiatives. Further, as the success of energy communities depends vastly on the participation of volunteers, also the commitment of actors is important to highlight (Young & Brans, 2017).

Other variables such as awareness about local energy projects, house ownership, ownership of renewable energy systems as well as a suburban or rural living area positively influence the WTP in collective energy initiatives (Kalkbrenner & Roosen, 2016; Koirala et al., 2018).

Overall, the TPB builds on rational consideration and argues that motivations are based on self-interest. It is assumed that attitudes and subjective norms are dependent on the evaluation of expected costs and benefits, such as money, time. However, the costs and benefits can also be of social nature, for example, the social approval through significant others (Lindenberg & Steg, 2007). The TPB has been widely used to study environmental behavior. It has previously proved to successfully explain the willingness to pay for abatement of forest regeneration (Pouta & Rekola, 2010), the use of public transport (Bamberg et al., 2003), the intention to act towards a local hydrogen refueling facility (Huijts et al., 2013) as well as energy use and saving (Abrahamse & Steg, 2009). It is interesting to see, that overall, attitudes explained the pro-environmental intention best, which indicated that the expected benefits and costs play an important role in determining the pro-environmental behavior (Lindenberg & Steg, 2007). Instead, Bamberg and Schmidt (2003) find that car and bus use was best explained by subjective norms, which indicates that expected social benefits and costs are important determinants when choosing the travel mode.

Despite the usefulness of the TPB in explaining the intention to behave, it also comes with several problems, which must be accounted for. Firstly, it has been criticized that the theory only considers how attitude, subjective norm, and perceived behavioral control influence the behavior. It gives, however, no insight into how these are formed, meaning the beliefs behind them. Secondly, the TPB has been criticized for excluding moral considerations (Manstead, 2000). It is argued that the intention to behave not only results from rational considerations and cost-benefits calculations but also depends on moral considerations through the activation of personal norms (Botetzagias et al., 2015). Notwithstanding these theoretical limitations and because of its strength in simplicity as well as visualizing and measuring the determinants of behavior, the TPB remains to be focal for this thesis. However, to consider the second aspect, in the next step, the NAM and VBN are presented, which explain behavior through moral considerations.

2.2.2 Norm Activation Model and Value Belief Norm Theory

The NAM (Schwartz, 1968, 1977) sets moral considerations in focus, attributing pro-environmental behavior to personal obligations represented through *personal norms* (see Figure 2-3*)*. While social norms reflect what is socially expected, *personal norms*[10] reflect the self-expectations, what an individual believes is right or wrong, and thus make you feel morally obliged through feelings of pride or guilt (Cialdini et al., 1990; Schwartz, 1977). Personal norms result from *"self-expectations […] experienced as feelings of moral obligation"* (Schwartz, 1977, p. 227). Schwartz (1977) considers personal norms as an internalized value system, which elicits the moral obligation (not) to perform a behavior. Schwartz and Howard emphasize the distinctiveness of personal norms to other attitudes by saying *that "[while] other attitudinal concepts refer to evaluations based on material, social, and/or psychological payoffs, personal norms focus exclusively on the evaluation of acts in terms of their moral worth to the self"* (1984, p. 245). The model defines two determinants activating the personal norms. The awareness that the (lacking) performance of a certain behavior has consequences (awareness of consequences or problem awareness) and the feeling of being responsible for social and environmental problems (ascription of responsibility) (Schwartz, 1977).

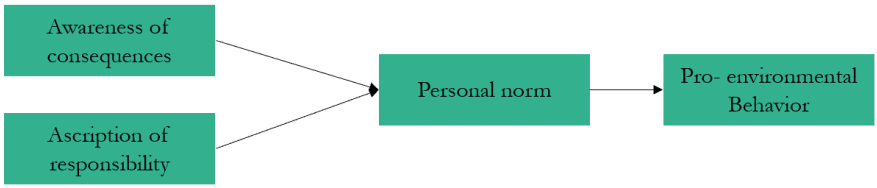

Figure 2-3: Norm Activation Model

Source: Adapted from Park (2014)

The VBN theory is an extension of the NAM by the influence of values, such as altruistic and egoistic and traditional values, as well as general beliefs on the relationship between nature and humankind, often measured as the New Ecological Paradigm (Stern et al., 1999). The authors describe the different factors with a causal chain as shown in Figure 2-4.

[10] In the literature sometimes also referred to as moral norms.

Figure 2-4: Value Belief Norm Theory

Source: Adapted from Stern (1999)

Although the NAM was originally developed in the context of altruistic behavior, it has been widely used to study environmental behavior, such as various pro-environmental intentions (Harland et al., 1999), in regard to public transport (Bamberg & Möser, 2007) and conservation behavior (Kaiser et al., 2005). Several studies have proven the influence of personal norms on pro-environmental behavior (Harland et al., 1999; Huijts et al., 2013; Kaiser et al., 2005). Regarding energy-related behavior, Chen (2016) shows for Taiwan that energy savings depend on moral obligation. So far, no studies exist measuring the impact of personal obligation due to self-expectations on the participation in RECs.

2.2.3 Theoretical framework of the willingness to participate in RECs

The TPB and NAM are developed as two discrete theories, which explain the WTP through rational and moral considerations. According to the goal framing theory, motivations are a heterogenous concept and distinguishes between hedonic (increase well-being), gain (increase resources), and normative (meet personal and subjective norms) goals. The theory suggests that behavior is influenced by the motivations of all goals but that one is dominating (Lindenberg & Steg, 2007). In line with this idea the use of a sole theory or model has been criticized and instead an integrated approach combining complementary theories has been suggested (Lindenberg & Steg, 2007; Steg et al., 2014).

While some authors find that the NAM or personal norms significantly adds explanatory value to the TPB (Harland et al., n.d.; Huijts et al., 2013; Klöckner, 2013), others did not (Heath & Gifford, 2002). In particular, the NAM has been especially successful to explain environmental behavior, which is associated with lower costs. Instead, when the behavior entails higher costs, such as effort, time, money, or inconvenience, the TPB seems to be a better predictor (Lindenberg & Steg, 2007; Mohana et al., n.d.). By way of example, the TPB is better in explaining the travel mode choice than the NAM (Bamberg et al., 2003).

Several studies have extended the TPB by the personal norm (Botetzagias et al., 2015; Chen, 2016; Harland et al., 1999). Despite the large agreement of integrating the personal norm into the TPB, disjoint exists if the personal norms have a direct or indirect effect on the behavior (Botetzagias et al., 2015; Klöckner, 2013). While the former means that the personal norm and TPB construct are mostly unrelated, the latter indicates that a high correlation between personal norms and some of the TPB concepts can be found. Some authors follow the second explanation with the idea that *"[p]art of the impact of personal norms on intentions is mediated by attitudes, meaning that what people consider favorable also takes into account if the respective behavior is in line with personal values"* (Klöckner, 2013, p. 1035). However, in the case of the recycling intention, Botetzagias (2015) found that the direct effect is higher than the indirect effect.

As there is empirical evidence that the explained variance increases when personal norms are included (Harland et al., 1999; Huijts et al., 2013; Onwezen et al., 2013), an extended model is used for the analysis of this thesis. In line with the goal framing theory, the extended model suggests that the willingness to participate in RECs is dependent on both: moral considerations, based on the NAM, and self-interest, based on the TPB.

From the NAM and TPB, the following hypotheses about the WTP in RECs can be drawn:

H1.1: The more positive the attitude towards RECs, the higher the WTP in RECs.

H1.2: The higher the perceived subjective norm, the higher the WTP in RECs.

H1.3: The higher the perceived behavioral control, the higher the WTP in RECs.

H2.1: The higher the personal norm, the higher the WTP in RECs.

Figure 2-5 visualizes the extended TPB model, which is used as theoretical foundation for the data collection and analysis.

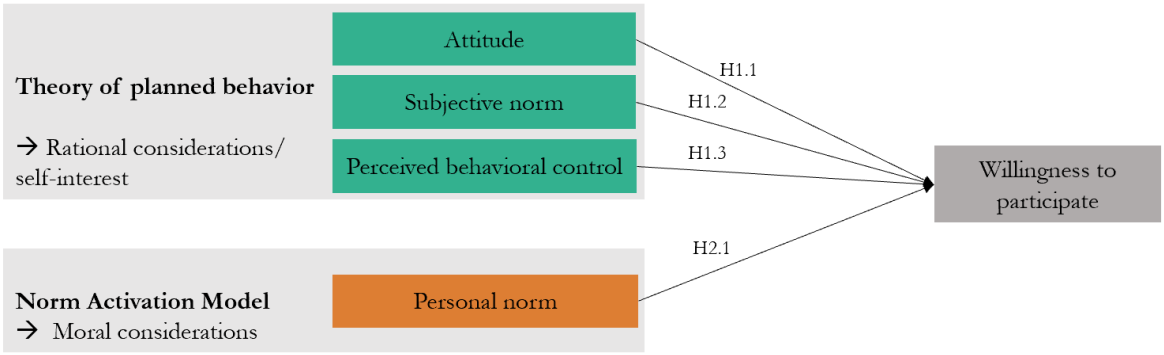

Figure 2-5: Extended model explaining the willingness to participate in RECs

Source: Own elaboration

3 Methodology

This chapter provides an overview of the methodological approach in order to answer the research questions posed in Section 1.3. Following the introduction of the data collection methods (3.1), including the questionnaire, description of the sample, and the conceptualization of the relevant variables, the data analysis methods are explored (3.2).

3.1 Methods for data collection

A cross-sectional survey is used as the primary method of collecting primary data because citizens can be directly addressed and the target group's opinion on RECs is captured. The time frame for the survey started on the 27th of February 2021 and ended on the 31st of March 2021. SoSci Survey, a free platform for scientific and independent research, was used to create the online survey.

The online survey is the preferred method of data collection because it allows for the collection of information on behavior, attitudes, and standard demographics. It is also cost-effective and can be managed remotely via online tools or third parties (Evans & Mathur, 2005; Sue & Ritter, 2015). The last aspect is especially important as, because of the COVID-19 lockdown, the possibilities for face-to-face data collection were limited. The self-administration of the questionnaire without an interviewer also reduces the social desirability bias on sensitive questions, which means giving a socially desirable answer rather than the true answer (Fowler, 2013). However, it is important to acknowledge the coverage error especially for online surveys, which occurs when the sampling population does not correspond to the targeted population (Fowler, 2013). For instance, it can be expected that elder people and people with lower education and income are unlikely to have the same access to computers and the internet as an average citizen (Von Bandilla et al., 2009).

3.1.1 Sampling and sample

The population of interest is all citizens living in Germany over the age of 18. The distribution of the survey among the target group proved to be difficult due to the limited financial and time resources of a master's thesis, as well as the lack of possibilities for organizations to distribute the survey in their network due to the data protection ordinance.

To overcome these challenges of reaching the target group of citizens online and due to time and cost efficiency, snowball sampling was used (Blaikie & Priest, 2019). In addition, the sample frames were chosen using purposive sampling. The main factors considered in this sampling were the access to the target group of citizens as well as the emphasis on diversity in age, income, gender, education.

On the one side, the survey was distributed through friends, family, and social media platforms, such as Facebook and Twitter. On the other side, the data collection was supported by third parties who facilitate access to the target group. For example, the online distribution of the survey was supported by the *Verbraucherzentrale Bundesverband*[11], the umbrella organization of the regional consumer advice centers, which independently represent the political interests of consumers. Among others, they offer energy consulting for households. With the mutual interest in renewable energy, they supported this survey by putting the online link to the survey on the main page of the energy consultation and share it on Twitter. Moreover, due to the homogenous membership of RECs, it is of particular concern to also target lower-income

[11] www.verbraucherzentrale-energieberatung.de

citizens. Therefore, the distribution of the survey was additionally supported by *Stromspar-Check*[12] (translated: electricity-saving check). This is a free, German-wide electricity-saving consultation especially for low-income households offered jointly by the German Caritas Association e. V. and the Federal Association of Energy and Climate Protection Agencies in Germany e. V. They train long-term unemployed as energy consultants for low-income households in topics around energy saving in the household. The online link of the survey was distributed through a newsletter to the consultants. Assuming a higher general difficulty to reach low-income citizens with online surveys minimizes the coverage bias of lower-income citizens (Sue & Ritter, 2015).

Sample characteristics

Non-probability sampling faces the risk that the results are not generalizable to a population as the exact inferential population is unknown and biases influence the sample identification (Blaikie & Priest, 2019; Sue & Ritter, 2015). Among others, Kerlinger (1978) criticizes that even with the principle of random selection in probability sampling, generalizability to national characteristics is not automatically given either due to limited accessibility to the target group, non-response rates, and small subsample numbers. Cook et al. (1979) further emphasize that random sampling can often not be applied due to a lack of resources. Therefore, when non-probability sampling strategies are applied, it is important to analyze to what extent sampling deviations appear. It is suggested to compare the fit of the sampling distribution to representative datasets through unidimensional comparisons, such as χ^2 tests (Prein et al., 1994). While the data comparison of a sample and the population does not guarantee the quality of the sample data, it at least provides hints about the statistical representativeness and the extent of the sampling bias in the variables examined (Schnell et al., 2018).

As part of this study, an overall sample of 298 citizens was achieved. Table 3-1 shows the distribution of the respondents for several standard demographic variables. The data was compared to the German population based on the German micro census[13] The χ^2 test reveals that except house ownership (χ^2=0.09, d.f.=1, p=0.76), all distributions are significantly different than in the German population. The descriptive results show that there is an oversampling of men compared to the German population (63% vs. 48%). Although it is uncertain if there are gender-specific differences regarding the participation in online surveys, it is mostly men, who are dominating the energy sector, which might have led to the oversampling of men (Smith, 2008; WECF e.V., 2020). Further, there is a relatively high number of citizens aged between 25 and 39 years (15% vs. 7%) as well as citizens between 50 and 64 years (39% vs. 24%) compared to the German population. Especially elder and younger people are underrepresented. The lack of elder participants can be explained as online surveys mostly reach people who have constant access to a computer and the internet. Further, the sample has a slightly lower share of citizens living in federal states who used to belong to former West Germany. It is also important to notice that the number of citizens with a high education level, meaning a tertiary education, is rather high (62%). While the previous experience with RECs is low (9.7%), more than half of the respondents (60%) have heard about RECs before.

[12] https://www.stromspar-check.de/

[13] The data is based on the 2011 Census data. As the houeshold net equivalent income was not freely available, income groups based on the socio-economi panel SOEP v34 (year 2016) were used for comparison (Bundeszentrale für politische Bildung, 2020))

Table 3-1: Demographic characteristics of respondents

	Sample No.	Sample %	German population %
Gender (χ^2=28.9, d.f.=1, p<0.001)			
Female	108	36.2	51.7
Male	187	62.8	48.3
Other	3	1.0	
Total	298	100.0	
Age (χ^2=111.15, d.f.=6, p<0.001)			
18-24 years	12	4.0	9.7
25-29 years	45	15.1	7.3
30-39 years	59	19.8	14.2
40-49 years	44	14.8	19.9
50-64 years	117	39.3	24.3
65-75 years	15	5.0	13.5
75 and more years	6	2.0	11.2
Total	298	100.0	
Living place (χ^2=6.4, d.f.=1, p<0.05)			
East	34	13.2	19.5
West	223	86.8	80.5
Total	257	100.0	
Occupation			
Working (χ^2=34.8, d.f.=1, p<0.001)	245	82.2	66
Jobless	11	3.7	
Retired	20	6.7	
Studying	22	7.4	
Total	298	100.0	
Education			
Low education	20	6.7	
Medium education	94	31.5	
High education	184	61.7	
Total	298	100.0	
Household net equiv. income (χ^2=36.6, d.f.=2, p<0.001)			
Lower income	55	20.6	24.4
Medium income	121	45.3	56
Higher income	91	34.1	19.6
Total	267	100.0	
House ownership (χ^2=0.09, d.f.=1, p=0.76)			
Tenant	163	54.7	54.5
Ownership	135	45.3	46.5
Total	298	100.0	
Type of community (χ^2=11.1, d.f.=1, p<0.001)			
Urban	180	60.4	77.4
Rural	118	39.6	23.6
Total	298	100.0	
Experience			
No	269	90.3	
Yes	29	9.7	
Total	298	100.0	
Awareness			
No	119	39.9	
Yes	179	60.1	
Total	298	100.0	

The comparison of the sample to the German population emphasized that there are only little overlaps between the sample and the population. Due to these constraints of non-probability sampling, as part of this study, no external generalization about the population can be made. However, the results are valid for the underlying sample and therefore allow to draw conclusions for the sample.

A power analysis based on effect size according to Cohen's d (Cohen, 1988) was conducted to estimate the statistical power of the survey data. With a sample of 298 and given a margin of error of 0.05 and a medium effect size of 0.5, a statistical power level of 99% can be achieved. From that follows that there is only a 1% chance of committing a Type II error for medium effect sizes. However, for small effect sizes (0.2), the sample reduces the statistical power to 40.3%, meaning that there is a higher uncertainty (~60%) for identifying small effect sizes in case they do exist. Thus, it is advised to interpret the results cautiously as the significance of the effect sizes can be underestimated (see Section 0 for discussion of limitations).

3.1.2 Questionnaire

A standardized questionnaire (see Annex A) was developed to capture the opinion of the respondents on the topic.

Reliability measures

During the development of the survey instrument, several measures were taken to reduce biases. Firstly, To reduce the non-response error of the survey, meaning the refusal of participation due to technical, confidentiality, or motivational barriers, the participation is incentivized with a lottery of five "Deutsche Bahn" vouchers among all participants (Fowler, 2013). To lower these starting barriers, the survey was developed with an online tool, which is easy to use, and anonymity was emphasized in the intro of the survey. Secondly, several measures were taken to avoid response bias. It was decided to use an even number Likert-Scale to avoid the tendency towards the middle but urge the respondents into one direction (Schnell et al., 2018). To prevent question order bias, randomization within the item batteries was conducted (Schnell et al., 2018). To pre-empt the acquiescence bias, meaning that respondents are more likely to agree, the scale orientation is changed for some items (Schnell et al., 2018).

Thirdly, measurement error, meaning the discrepancy between the stated and true responses, must be accounted for (Couper, 2000). An interesting but objective intro, the Lund University logo supporting the scientificity of the study as well as a progress bar, indicating the progress throughout the survey, were measures taken to keep the motivation of the respondents high. To increase the reliability of the instrument, high importance was placed on ensuring a consistent interpretation, the exact wording of the questions, the use of well-defined terms, and the application of only unidimensional questions (Fowler, 1995). To further increase the validity of especially subjective questions, concepts were covered through several items. The respondents were mostly asked for their assessment of statement questions to be able to use similar scales throughout to make it easier for the respondent. The answers were captured through Likert-Scales from 1 to at least 6, which were labeled at the extreme values, and allowed variation in responses.

Additionally, before the actual survey started, a pre-test was conducted to test the items and the adequacy of the design. On one hand, the survey was distributed among friends, batch members as well as contact persons of the supporting institutions (around 20 persons). Throughout the pre-test, special attention was also given to filter variables as well as comprehensible language and correct formulation. On the other hand, the pre-test methods "paraphrasing" and "think-aloud" were used to better understand the respondents' reactions. Thereby, two pre-test respondents were asked to repeat the question in their own words and share their thoughts on the questions (Schnell et al., 2018).

The questionnaire first explains the project and the instructions for the task. Then the concept of local RECs is introduced by giving a very open definition, which does not go into detail about the type or financing mechanism of the RECs. Although some responses might be dependent on details, such as the financing mechanism, it was decided on purpose to offer a rather simple and neutral explanation, as the main aim of this study is to know more about the general WTP in RECs. With the instruction *"please imagine that a local renewable energy community was recently established in your neighborhood"* a hypothetical scenario is created. The questions capturing the main concepts of the dependent and independent variables are followed by questions asking for additional information on the person and the household, such as the previous awareness about and participation in a REC as well as details on the socio-demographic background.

Conceptualization and operationalization

Table 3-2 shows the conceptualization of the main concepts. A detailed description of the operationalization of the relevant variables for the data analysis can be found in Annex B, Table 0-1. All items are based on existing literature on the TPB and the NAM. The items were adapted to the topic, translated, and rephrased.

The WTP in a REC was captured with two items asking for the willingness to *actively engage* and *to invest*. The respondents were able to rate their willingness on a Likert scale from 1 (very low) to 8 (very high) with labels only on the extreme variables. This form of Likert scale allows to interpret the scale as interval measurement, as the distances between the categories on the scale can be assumed equal (Hair et al., 2019; Wakita et al., 2012). Depending on the respondent's positive or negative tendency towards the active engagement and the financial investment, in a follow-up question for each participation type, the motivations and barriers for the respondent's attention were enquired. Several options and other categories were given but the respondent was asked to choose the main reason.

Table 3-2: Conceptualization of the main theoretical concepts

Concept	Question	Source	Modification
Willingness to participate	How high would your willingness to invest money in this local renewable energy community be? How high would your willingness to actively engage in this local renewable energy community be?	Adapted from Kalkbrenner & Roosen (2016)	Translated; Rephrased: "actively engaged" instead of "invest time in or volunteer"
Theory of Planned Behavior			
Subjective norm	Most people that are important to me … … think that I should be against renewable energy communities. … think that my participation in a renewable energy community is an important thing to do. … would approve of me participating in a renewable energy community.	Adapted from Brayley (2015)	Translated; Rephrased
Attitude towards acting	The participation in the local renewable energy communities is … … unimportant - important … useless - useful … bad - good	Adapted from Ajzen (2005); Brayley (2015)	Translated; Rephrased
Perceived behavioral control	I have complete control over whether I participate in the local renewable energy community. It would be difficult for me to participate in the local renewable energy community. I am confident that I could participate in the local renewable energy community. It is mostly up to me whether I participate in a local renewable energy community.	Adapted from Brayley (2015)	Translated; Rephrased
Norm Activation Model/Value Belief Norm Theory			
Personal norm	I feel guilty if I do not participate in a renewable energy community. If I acted according to my principles, I would not participate in a renewable energy community. I feel morally obliged to participate in a renewable energy community.	Adapted from Huijts et al. (2013)	Translated; Rephrased

The Cronbach's α and the inter-item correlations were analyzed to examine the internal consistency of the scale and the correlation between the items (Cortina, 1993; Piedmont, 2014).[14] Together, both items formed a scale with sufficient internal consistency (Cronbach's α = 0.82). An inter-item correlation of 0.70 suggests however a narrow conceptualization.

The TPB is divided into three concepts: The *subjective norm* is captured as the respondent's perceived opinion of important others regarding their participation in the REC (Huijts et al., 2013). On a Likert-Scale from 1 (fully disagree) to 5 (fully agree), three statements measured the subjective norm. Due to a comparable lower Cronbach's Alpha of 0.620, additionally, the inter-item correlations were tested. As the item *"Most people that are important to me think that my participation in a renewable energy community is an important thing to do."* indicated a low inter-item correlation (0.11), it was excluded from the index. Therefore, the additive index of only two items was used to measure the subjective norm. The *attitude towards acting* is captured as the general evaluation of the participation in local RECs and is measured with three attitudes (good-bad, useless-useful, unimportant-important) on a Likert scale from 1 to 7 (Icek Ajzen, 2005; Brayley et al., 2015). In this case, a middle category was used to allow neutrality. The additive index of the items was used to measure the attitude towards acting (Cronbach's α = 0.894; average inter-item correlation = 0.738). The high inter-item correlations (>0.7) suggest however a redundant conceptualization (also see limitations in Section 0). The *perceived behavioral control* is captured with four items as the respondent's perception of the degree of difficulty to participate in RECs and was measured as statements on a Likert scale from 1 (fully disagree) to 5 (fully agree) (Huijts et al., 2013). The additive index of the items was used to measure the perceived behavioral control (Cronbach's α = 0.60; average inter-item correlation = 0.274). The inter-item correlations among the items were in line with the suggested range between 0.2 and 0.4.

The *personal norm* reflects to what extent the respondent feels personally obliged to participate in the REC and was measured on a Likert Scale from 1 (fully disagree) to 5 (fully agree) (Huijts et al., 2013). Due to a comparable lower Cronbach's Alpha of 0.562, additionally, the inter-item correlations were tested. As the item "*If I acted according to my principles, I would not participate in a renewable energy community."* indicated a low inter-item correlation (0.152), it was excluded from the index. Therefore, the additive index of only two items was used to measure the personal norm.

3.2 Methods for data analysis

As part of the data analysis, several bi- and multivariate statistical methods, as well as non-parametric tests, were conducted using STATA 16 to explore the relationship among the variables and to compare gender and income groups.

3.2.1 **Methods to explore relationships among variables**

To better understand the relationship between the socio-psychological determinants and the WTP, correlations between the variables are analyzed. Specifically, a non-parametric Spearman's rank correlation coefficient to measure a monotonic correlation is used to avoid the influence of outliers (Schober et al., 2018). Partial correlation analyses are used to indicate the relative contribution of each independent variable (square of semi partial correlation) (Hankins et al.,

[14] Cronbach's α gives an indication for the internal consistency and reliability of the scale. 0.7 is usually an accepted value. Due to the sensitvity to the number of items, it is suggested to additionally examine the actual correlation between the variables (Cortina, 1993). An average inter-item correlation between 0.2 and 0.4 is suggested to guarantee homogenity while allowing enough variance to avoid only capturing a narrow part of the construct (Piedmont 2014).

2000). As the variables do not follow a normal distribution and outliers were identified, the variables were ranked before.

Multiple linear regressions are used to test the linear relationship between the various variables. The "Ordinary Least Squares" (OLS) procedure strives for a minimization of the squared difference between the true and estimated values (Kohler & Kreuter, 2016). This allows us to test the hypotheses under H1 and H2. The linear relationship can be depicted with the following equation:

$$\hat{y} = b_0 + b_1 x_{1i} + b_2 x_{2i} + \cdots + b_j x_{ji}$$

The estimated dependent variable $\hat{y}$ (here WTP in REC) will be estimated through several independent variables x_i. b_j describes the slope for case i and b_0 is the constant (meaning the value when all independent variables are 0) (Kohler & Kreuter, 2016). To answer the first and second RQ, a stepwise regression with the WTP as a dependent variable was conducted. At first, the explanatory power of the TPB in predicting the WTP in RECs is presented with the independent variables being attitude, subjective norm, and perceived behavioral control. Then, as part of the extended TPB, personal norm was added to allow a comparison of the explanatory power to the TPB. It was decided to only focus on the direct antecedents as suggested by the theory and not the behavioral, normative, attitudinal beliefs as well as ascription of responsibility and problem awareness or values, as the focus of this study is to understand the behavioral intention and unnecessary correlations among the independent variables were avoided.

The results of the extended model were further tested by controlling for important control variables. The test of control variables is conducted in line with the assumption that the extended TPB model mediates the effect of socio-demographic variables and the WTP (I Ajzen & Fishbein, 1980). The previous awareness about RECs was included to control whether the respondents have previously heard about RECs as this could influence the background knowledge they have on RECs. To control for internal factors influencing the perceived behavioral control, socio-demographic variables, such as gender, age, income groups (based on monthly net equivalent income), and education, were kept constant. Additional, information on the house ownership and living area was controlled for as citizens who live in cities and are tenants might feel less capable as energy communities in the city have not been discussed a lot and tenants are less bound to their residency. [15] To answer the third RQ and estimate the relative weight of the TPB variables among income groups and gender, separate regressions for lower-/middle and higher-income groups and women and men were calculated. The comparison of groups only includes the TPB variables as the personal norm seems to have a low additional explanatory power (see Section 4.2).

It is important to emphasize that the significance levels can only be interpreted as significant within the sample as the generalization to the population is not possible due to a lacking representativity. Instead of only looking at the b coefficients, special attention is given to the standardized beta coefficients (β), which allow conclusions on the size of the effect as it takes the scale of the variables into account (Sapsford, 2007). The coefficient of determination R^2 can be interpreted as the extent to which the model fits the data, so how much percentage of the squared residues is explained by the model (Kohler & Kreuter, 2016). To test the mediating role of attitude, the commonly known approach for mediation analyses after Baron and Kenny

[15] A variable controlling for the previous experience as well as the influence of the energy training of the *Stromspar-Check* was included to remove potential bias. As no changes were encountered and due to a very low number stating previous experience (n=29) or that they work as energy consultants (n=32), the control variable was neglected. Both effects were insignificant.

(1986), adjusted by Iacobucci et al. (2007), is applied. Bootstrapping with 1000 replications, a resampling method to account for the non-normal data was used as recommended by Lai (2018). A Sobel's z-test (1982) is used to prove the significance of the effects.

3.2.2 Methods to compare groups

To compare the results in regard to different groups, several non-parametric tests are conducted. A χ^2 test for independence was conducted to compare the representativeness of the sample compared to the German population. It is also called the "goodness of fit" statistic and indicates how the observed distribution represents the expected distribution (Sapsford, 2007). The Fisher's exact test is applied as an alternative to the Chi-square test to analyze the relationship among two categorial, as it does not assume a cell frequency greater than five (UCLA, n.d.). This is important when analyzing the motivations for and barriers to participation in RECs by gender and income groups.

To test the statistical difference between the underlying distributions of a variable (at least ordinal) among different categories, a Mann-Whitney U test was conducted, for example for the difference in WTP in RECs between males and females (UCLA, n.d.). When the difference between more than two categories is tested, such as for the income groups, a Kruskal-Wallis test was used, followed by a Dunn test to specify the categories between which a significant difference exists (Dunn, 1961). An adjustment after Bonferroni was applied for the comparison of multiple groups. The method alters the rejection level of the null hypothesis by dividing α by the amount of groups (Dinno, 2015)

Assumptions of regression model

The requirements for the OLS model are given under the Gauss-Markov assumptions (Kohler & Kreuter, 2016). The combined model was tested for the normal distribution of residuals, heteroskedasticity (unequal variance of error term), and linearity (see Annex Figure 0-1, Figure 0-4). Further, for each model multicollinearity (linear association between two independent variables) was tested. Overall, only VIF values below the tolerance value of 5 suggested by Urban and Mayerl (2006) were identified (O'Brien (2007) defined critical value at 10). Additionally, the sample was analyzed for outliers, meaning cases with high residuals due to unusual values on the dependent variable, relative to the value on the independent variables. Therefore, the DEBETA values were calculated, which stepwise identifies cases by comparing the regression model with and without a case. For each coefficient, several cases above the low critical value of $|\text{DFBETA}| > 2\sqrt{N}$ (here 0.12) were found, which were however lower than the higher critical value of 1, which is suggested by other authors (Belsey et al., 1980; Bollen & Jackman, 1985). Thus, additionally, Cook's D is calculated, which accounts for the leverage additional to the distance, meaning unusual values on the independent values (see Figure 0-2, Figure 0-3). It measures the influence of one case on all coefficients simultaneously and highlights cases with high leverage, meaning unusual values on the independent and dependent variables (Kohler & Kreuter, 2016). There are several cases identified that are higher than the low critical value of |COOK's D| > 4/N (here 0.013) but none of them were higher than 1 (Kohler & Kreuter, 2016). As the plausibility of the cases seems reasonable and the values are lower than the high cut-off values, it was decided not to exclude the outliers. To account for the heteroskedasticity caused by outliers, robust standard errors are estimated, which gives more accurate values by calculating the standard error based on the true instead of the estimated variance (Hayes & Cai, 2007; Long & Ervin, 2000). [16]

[16] The conservative robust estimator HC3 is used, which considers the leverage and has been suggested for small samples by Long (2000). The results were compared to bootstrapping with 1000 replications. No major differences were observed.

4 Empirical findings and analysis

This chapter gives an insight into the results of the data analysis. After introducing the general findings on the WTP and the socio-psychological variables (4.1), the relationship between the socio-psychological determinants and the WTP is explored (4.2). Then, a comparison of income groups and gender is conducted (4.3). Finally, the results are summarized by testing the hypotheses from Section 2.2.3 (4.4).

4.1 Descriptive findings on the central variables

The index willingness to participate was inquired in two dimensions. According to Table 4-1, the general willingness to invest is on average slightly more positive (mean=5.4) than the willingness to actively engage (mean=5). Regarding the willingness to actively engage, the respondents indicated more values around the middle categories, which leaves to assume that they have less strong opinions about it or are rather undecided. A Mann-Whitney-U test was conducted to test the difference between the two dimensions and the results show that the willingness to actively engage is significantly lower than the willingness to invest ($z= -9.54$; $p<0.001$).

Table 4-1: Descriptive statistics of the willingness to participate

	N	$\bar{x}$	s	Min	Max	Skewness
Willingness to participate [index]	298	5.218	1.874	1	8	-0.565
Willingness to actively engage	298	4.993	1.995	1	8	-0.332
Willingness to invest	298	5.443	2.071	1	8	-0.673

The distribution of the index on the WTP is shown in Figure 4-1.

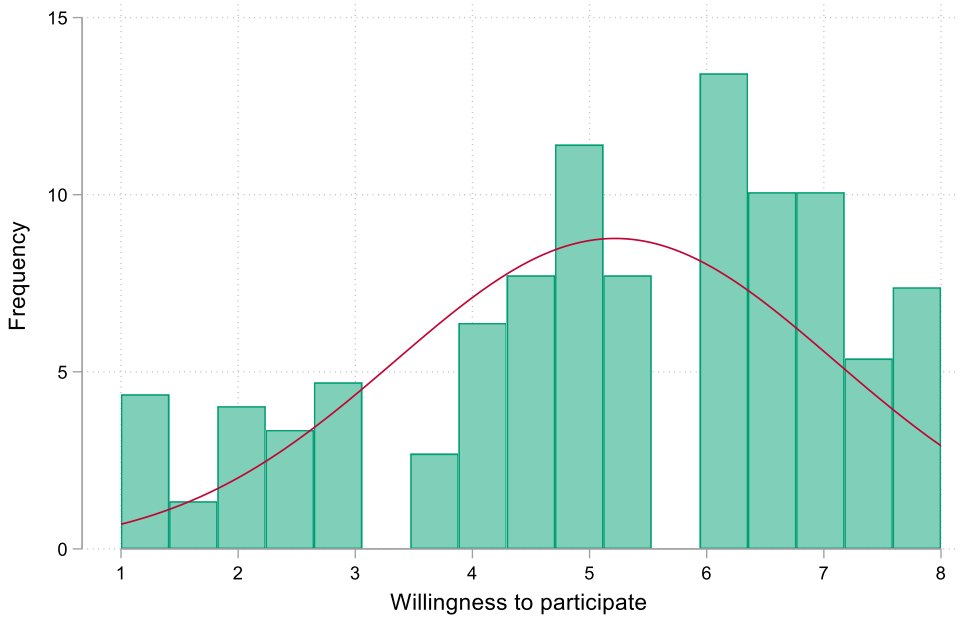

Figure 4-1: Histogram and normal distribution - Willingness to participate [index]

To better understand the relationship between each dependent and independent variable, Table 4-2 displays the pairwise correlation matrix. Overall, it shows low to moderate positive correlations (Cohen, 1988)[17]. Only the correlation between perceived behavioral control (tpb_behcontrol) and personal norm (nam_persnorm) is low and insignificant. All variables are significantly correlated with the willingness to participate. Especially attitude shows a very large correlation to the willingness to participate (r=0.63; p<0.001).

Table 4-2: Spearman's Rho correlation matrix

	wtp_index	tpb_attitude	tpb_subnorms	tpb_behcontrol
tpb_attitude	0.63***			
tpb_subnorms	0.43***	0.51***		
tpb_behcontrol	0.45***	0.42***	0.27***	
nam_persnorm	0.30***	0.48***	0.32***	0.09

* p<0,05 ** p<0,01 *** p<0,001

As shown through the mean ($\bar{x}$) in Table 4-3, most central variables of interest show on average slightly higher values than the mean (for attitude mean=4; for other variables mean =3.5). Especially regarding the attitude, respondents perceive RECs as rather positive. However, the personal norm is rather low compared to the mean suggesting a low moral obligation.

Table 4-3: Descriptive statistics of independent variables

	N	$\bar{x}$	s	Min	Max	Skewness
TPB: Attitude	298	5.568	1.310	1	7	-1.315
TPB: Subjective norm	298	4.238	1.171	1	6	-0.656
TPB: Perceived behavioral control	298	4.450	1.028	1.500	6	-0.505
NAM: Personal norm	298	2.789	1.356	1	6	0.331

4.2 Socio-psychological determinants of the willingness to participate

To better understand the influence of socio-psychological factors on the WTP, a multivariate regression analysis was conducted. To answer the first and second RQ, a stepwise regression with the WTP as a dependent variable was conducted. At first, the explanatory power of the TPB in predicting the WTP in RECs is presented. Then, as part of the extended TPB, personal norm was added to allow a comparison of the explanatory power to the TPB. The results of the extended model are presented and further tested by controlling for socio-demographic variables. As summarized under hypotheses H1.1, H1.2, and H1.3, the variables of TPB are expected to positively influence the WTP in RECs. As concluded in H2.1, a positive relationship between the personal norm and the WTP in RECs expected.

TPB Model

Firstly, the relationship between the TPB variables and the WTP in RECs is analyzed (see Table 4-4). No multicollinearity was identified for the model (mean VIF=1.40). The three TPB variables were able to explain a moderate amount of variance (R^2= 0.51; F(3, 294 = 125.41; p<0.001) in the WTP. For the TPB model, all variables show a positive and significant contribution. Respondents with a more positive attitude (β=0.54; p< .001) towards RECs, a higher subjective norm (β= 0.13; p< .05) and a higher perceived behavioral control (β= 0.19; p< .001) have a higher WTP in RECs. The standardized coefficients indicate that attitude has the biggest influence, meaning that one increase in the standard deviation of attitude (s=1.3) leads to an increase of 0.54 standard deviations in the WTP (s=1.9). The results obtained

[17] Cohen (1988) suggests a correlation coefficient of 0.1 as small, 0.3 medium and 0.5 as large.

emphasize the importance of the TPB model in predicting the WTP in RECs. The partial correlation analysis reveals that some of the effects of subjective norms and perceived behavioral control are mediated through attitude. However, the mediation effect is partial only, as the significant direct effect remains (see Table 0-2).

Extended TPB Model

Secondly, the relationship between, the extended TPB model and the WTP in RECs is analyzed. No multicollinearity was identified for the model (mean VIF=1.45). The TPB variables and personal norm together accounted for 51% of the explained in the WTP in RECs (R^2= 0.51; F(4, 293=94.77; p<0.001). Compared to the first TPB model, the explained variance increases only by 0.08% in the extended TPB model by adding the personal norm. A Wald-test proved that including the personal norm does not lead to a statistically significant improvement in the model fit (LR $\chi^2(1)$ = 0.49; p=0.4857).

Respondents with a more positive attitude (β=0.53; p<0.001) towards RECs, a higher subjective norm (β= 0.12; p<0.05) and a higher perceived behavioral control (β= 0.19; p<0.001) have a higher WTP in RECs. The effect of personal norm is very low and insignificant (β= 0.03; p>0.05).

Table 4-4: Linear regression - Willingness to participate (standard. coefficients; robust standard errors)

	TPB		Extended TPB	
TPB: Subjective norm	0.125*	(0.0956)	0.121*	(0.0963)
TPB: Perceived behavioral control	0.191***	(0.0868)	0.193***	(0.0875)
TPB: Attitude	0.540***	(0.0796)	0.525***	(0.0821)
NAM: Personal norm			0.033	(0.0656)
Observations	298		298	
R-squared	0.51		0.51	

Standarderror in brackets; * p<0,05 ** p<0,01 *** p<0,001

Partial correlation analysis (see Annex B, Table 0-2) shows that the relative contribution of each independent variable (square of semi partial correlation) is biggest for the attitude (12%), followed by the perceived behavioral control (3%), subjective norms (1%) and personal norm (0.03%). Thus, most variance is shared between the variables (Hankins et al., 2000). The partial correlation analysis further reveals that under the control of the TPB variables, the statistically significant, medium bi-variate correlation of personal norm with the WTP (r=0.3; p<0.001) decreases and turns insignificant (r=0.03; p>0.05). This leaves to assume that the effect of the personal norm is mediated by the attitude as individuals with a very positive attitude most likely also have stronger personal norms.

To test the effect of the personal norm through the attitude, a mediation analysis was conducted while controlling for subjective norms and behavioral control. In Table 4-5 you can see that the indirect effect of the personal norm on the WTP through the attitude is significant (β=0.35; p<0.001). The direct effect was minimized and turned negative (β=0.05; p=0.486) after controlling for the mediator, which indicates a complete mediation. In fact, the effect revealed that about 89% of the effect of the personal norm on the WTP is mediated by the attitude. This conclusion was confirmed by a Sobel test (z=6.4337; p < .001).

Table 4-5: Mediation analysis - (bootstrap standard errors and confidence intervals)

Exogenous variable (X)	Mediator (M)	Endogenous variable (Y)	Coef. b (X → M, a)	Coef. b (M → Y, b)	Effect (a x b)	BCa bootstrap 95% CI[18]	
Personal norm	Attitude	WTP	0.465***	0.751***	0.349** (indirect)	.3591377	.5666404
Personal norm		WTP			0.045 (direct)	-.0863939	.1647251

Extended TPB Model and control variables

In the next step, to ensure consistency and control for internal factors of the perceived behavioral control, the combined model is further tested by including control variables (see Table 4-6). No multicollinearity was identified for the model (mean VIF = 1.91). The test of control variables is conducted in line with the assumption that the extended TPB model mediates the effect of socio-demographic variables and the WTP (I Ajzen & Fishbein, 1980). When controlling for demographics, such as gender, age, household net equivalent income, and the living area as well as house ownership, the number of observations decreases to 266 as there is no information on the financial situation of 31 participants and the age of one participant.

Compared to the extended TPB model, which indicates the values before controlling for other independent variables, the control variables increase explanatory power by around 8% (R^2= 0.58; $F(14, 251)=30.73$; $p<0.001$). While the main effects of subjective norm and attitude slightly increase and remain significant, the effect of perceived behavioral control decreases and turns insignificant ($b=0.156$; $p>0.05$). The perceived behavioral control thus seemed to be highly influenced by internal control factors (such as financial resources, skills, time). A closer look at the difference between the willingness to participate and the willingness to invest (see Table 0-3 and Table 0-4), shows that perceived behavioral control reduces to a minimal and turns insignificant for the former ($b=0.065$; $p>0.05$) but remains significant for the latter despite controlling for internal factors ($b=0.246$; $p<0.05$).

As the questionnaire only gave limited prior information on what RECs are, the previous awareness of RECs was controlled for. Citizens with previous awareness have a significantly higher WTP ($b=0.74$; $p<0.001$) than respondents without previous awareness. To test the significance between the groups, an MWU test was conducted, and it was found that respondents without previous awareness are significantly less willing to participate ($z= -5.428$; $p<0.001$) compared to respondents with previous awareness.

Regarding the effect of income, citizens with medium ($\beta=0.79$; $p<0.01$) and higher income ($b= 0.72$; $p<0.01$) have a significantly higher willingness to participate than citizens with lower income. The difference in effect between men and women is marginal ($\beta=0.07$; $p>0.05$).[19] Concerning the influence of age and the living situation regarding ownership and the area, the results show only minor and insignificant differences.

[18] Bias-corrected and accelerated confidence (95%)

[19] The interpretation of the effect of the "Other" gender category must be neglected as the numbers represent only three citizens.

Table 4-6: Linear regression - Willingness to participate and control variables (unstandard. coefficients; robust standard errors)

	Extended TPB		+ Control Var.	
TPB: Subjective norm	0.224*	(0.101)	0.248**	(0.0955)
TPB: Perceived behavioral control	0.344***	(0.0939)	0.156	(0.0952)
TPB: Attitude	0.744***	(0.0869)	0.750***	(0.0869)
NAM: Personal norm	0.0385	(0.0699)	0.0494	(0.0655)
Previous awareness (*Ref.: No*):			ref.	
Yes			0.744***	(0.176)
HH net-equiv. income (*Ref.: Low*):			ref.	
Medium income			0.793**	(0.252)
Higher income			0.720**	(0.275)
Gender (*Ref.: Female*):			ref.	
Male			0.0712	(0.175)
Other			-0.899*	(0.417)
Age			-0.00829	(0.00748)
Living area (*Ref.: Urban*):			ref.	
Rural			0.151	(0.172)
House ownership (*Ref.: Tenant*):			ref.	
Ownership			0.325	(0.203)
Education (*Ref.: Low*):			ref.	
Medium education			0.100	(0.346)
High education			0.121	(0.356)
Constant	-1.493**	(0.449)	-1.852**	(0.605)
Observations	266		266	
R-squared	0.50		0.58	

Ref. = Reference Category; Standarderror in brackets; * p<0,05 ** p<0,01 *** p<0,001

Overall, it can be summarized that the TPB explains the WTP in RECs moderately well and that the effect of the personal norm does not significantly add to the explained variance in the WTP. Instead, the effect of personal norms is mediated through the attitude. Among the central independent variables, attitude has the biggest, significant influence on the WTP. Among the control variables, previous awareness and a medium and high income significantly and positively influence the WTP in RECs. As TPB turned out to be central for explaining the WTP and the personal norm does not add explanatory power, further analysis is based on the model of TPB. It is analyzed, to what extent the influence of TPB differs between gender and income groups.

4.3 Group comparison

To better understand the reasons for the current homogeneity of membership in RECs in Germany, particular interest is given to differences in the socio-psychological determinants and their influence on the WTP between income groups and gender.

4.3.1 Income

The linear regression had shown that the WTP of the lower-income group is substantially lower than the WTP of medium and higher-income groups. As the observations of citizens from lower-income households are only 55, additionally a non-parametric test was conducted. The Kruskal-Wallis test supports the finding that the probability that one income class is different from the other in regard to the WTP is significant (χ^2 = 13.055; df=2; p<0.001; see in Table 0-7). A pairwise comparison of the income groups was conducted using a Dunn test (Dunn, 1961). After adjusting for multiple comparisons through Bonferroni, it shows that both, the medium and higher-income groups, have a significantly lower willingness to participate than the lower income group (for both comparisons p<0.001; see Annex Table 0-9). This finding is

further supported by the difference in the median[20], which is depicted in Figure 4-2, whereby the difference is higher in the willingness for active engagement than in the willingness for financial investments.

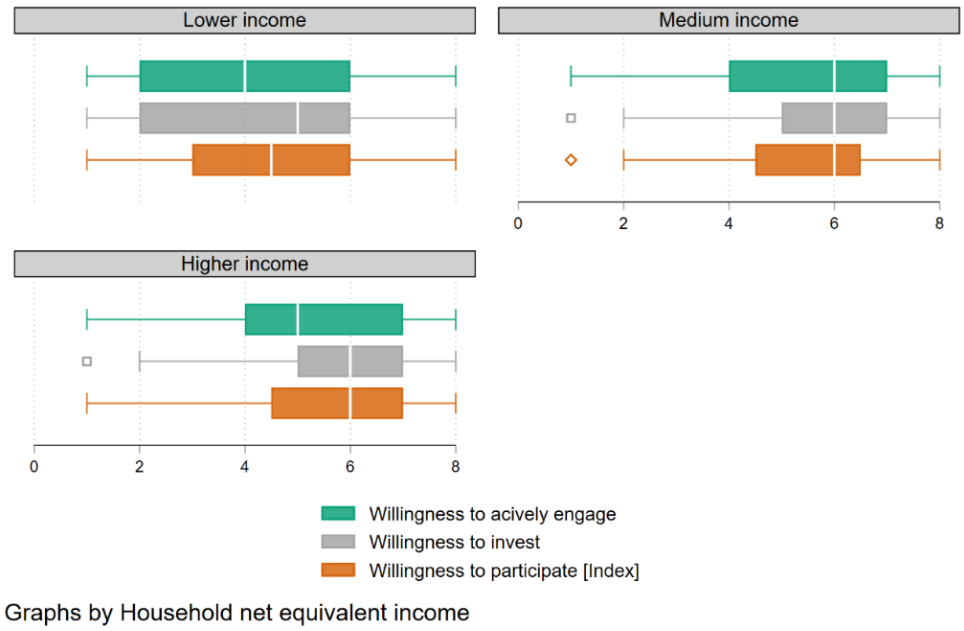

Figure 4-2: Willingness to participate, actively engage and invest by income groups

Moreover, income differences in regard to the socio-psychological determinants were tested. The Kruskal-Wallis tests reveal that there is only a significant difference in the perceived behavioral control between the income groups (χ^2 = 21.750; df=2; p<0.001). The pairwise comparison through the Dunn test showed that the medium and higher income group is significantly different from the lower-income group (p<0.001; see Annex Table 0-10). The higher the income group, on average, the higher the perceived behavioral control (lower-income group median=4; medium-income group mean=4.75; higher-income group mean=4.75) (see Figure 4-3 and Annex Table 0-6 for mean).

[20] While the median indicated the middle of the scalesee, the mean indicates the average of all numbers (adding all numbers and dividing it by the total amount of numbers).

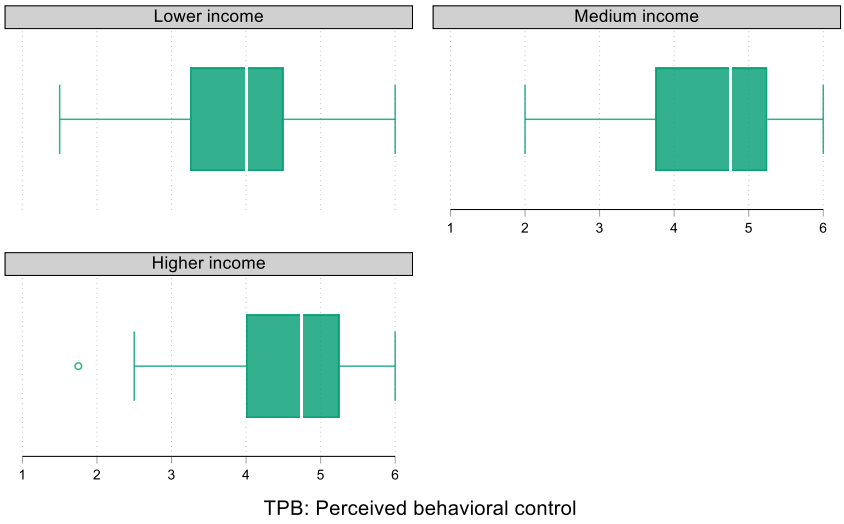

Figure 4-3: Significant differences in socio-psychological determinants by income

To better understand the relative impacts of socio-psychological determinants on the WTP according to the income, a linear regression of the TPB separated by income classes was conducted (see Table 4-7). No multicollinearity was identified for the model (lower-income: mean VIF =1.45; middle income: mean VIF=1.38; higher-income mean VIF =1.44). As the sample size of the groups is rather low, it is important to mention, that with the low sample size the statistical power decreases. For instance, the uncertainty of committing a Type II error increases to 56% for a sample size of 55.

The TPB variables were able to explain a moderate amount of variance for the lower-income group (R2= 0.54; $F(3, 51 = 15.56$; $p<0.001$), medium-income group (R2= 0.42; $F(3, 117 = 25.05$; $p<0.001$) and the higher-income group (R2= 0.61; $F(3, 87 = 53.59$; $p<0.001$). The influence of attitude is still highly important over all groups, meaning the more positive the attitude towards RECs the higher is the WTP (lower-income groups: $\beta=0.68$; $p< 0.001$; medium-income groups: $\beta=0.51$; $p<0.001$; higher-income groups: $\beta=0.53$; $p< 0.001$). It appears that while subjective norms have a relatively high influence for the middle ($\beta=0.21$; $p< 0.05$) and higher-income groups ($\beta=0.20$; $p< 0.01$) (significant only for middle-income groups) the influence of subjective norms for the lower-income group is low and insignificant ($\beta=0.05$; $p>0.05$). The effect of the perceived behavioral control is significant and substantial for high income ($\beta=0.25$; $p<0.01$) but insignificant and minor for lower- ($\beta=0.05$; $p>0.05$) and middle-income ($\beta=0.02$; $p>0.05$) groups.

Table 4-7: Linear regression - Willingness to participate by income groups (standardized coefficients; robust standard errors)

	Lower income		Middle income		Higher income	
TPB: Attitude	0.682***	(0.211)	0.513***	(0.132)	0.532***	(0.135)
TPB: Subjective norm	0.047	(0.236)	0.207*	(0.130)	0.200	(0.158)
TPB: Perceived behavioral control	0.052	(0.213)	0.016	(0.154)	0.254**	(0.166)
Observations	55		121		91	
R-squared	0.54		0.42		0.61	

Standarderror in brackets; * p<0,05 ** p<0,01 *** p<0,001

4.3.2 Gender

Similar to the income comparison, a gender comparison was conducted. As already indicated by the results of the linear regression, there is no substantial difference in the WTP between the genders, but males have on average a slightly higher WTP. A nonparametric Mann-Whitney-U test supports that finding that there is no significant difference between males and females ($z=-1.273$; $p= 0.2034$; see Annex Table 0-5).

Although no differences in regard to the WTP were shown, the gender differences in the socio-psychological determinants were tested. Mann-Whitney-U tests reveal that there are significant differences between women and men regarding the personal norm ($z= 3.74$; $p<0.001$) and perceived behavioral control ($z= -2.28$; $p<0.05$). Women have on average a slightly higher personal norm (females median=3; males median=2.5) but men have on average a slightly higher perceived behavioral control (females median=4.5; males median=4.75) (see Figure 4-4 and Annex Table 0-6 for mean).

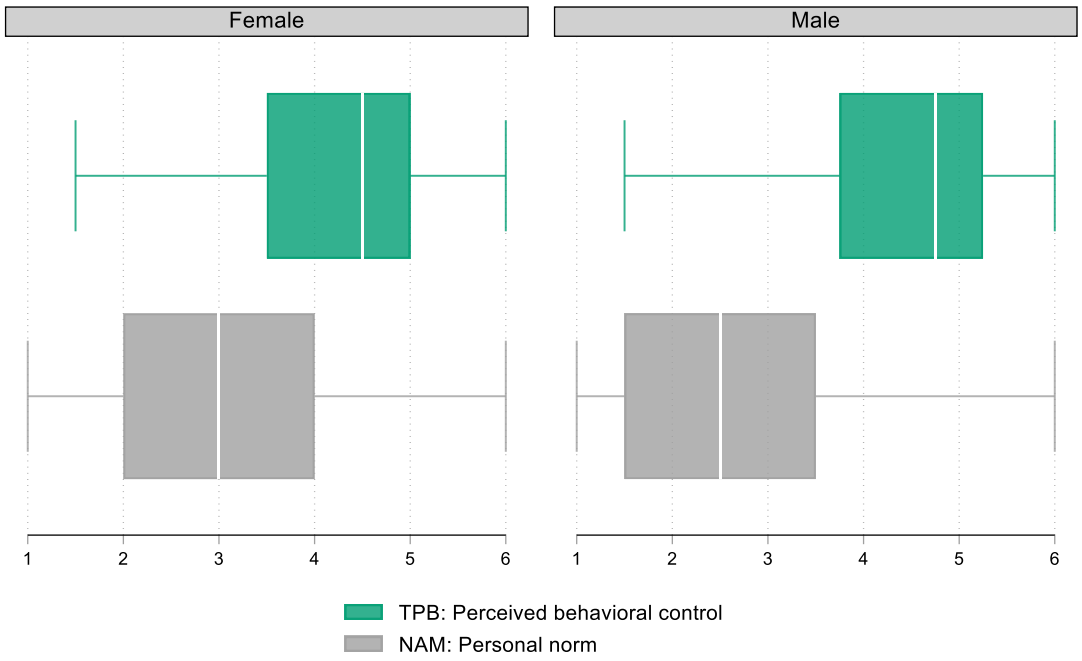

Figure 4-4: Significant differences in socio-psychological determinants by gender

To better understand the differences in gender of the impact of socio-psychological factors on the WTP, a linear regression of the TPB separated by gender was conducted (see Table 4-). No multicollinearity was identified for the models (women: mean VIF =1.24; men: mean VIF=1.85). However, the sample size is rather low, which increases the uncertainty of committing a Type-II error. For women, the TPB variables were able to explain a moderate amount of variance ($R^2= 0.48$; $F(3, 183 = 57.65$; $p<0.001$) in the WTP. For men, the TPB variables were able to explain a moderate amount of variance ($R^2= 0.54$; $F(3, 104 = 84.60$; $p<0.001$) in WTP.

The influence of attitude and is highly important for men and women, meaning the more positive the attitude towards RECs the higher is the WTP (women: $\beta=0.61$; $p< 0.001$; men: $\beta=0.83$; $p< 0.001$). Also the effect of higher perceived behavioral control is significant for both groups (women $\beta=0.29$; $p<0.05$; men ($\beta=0.37$; $p<0.01$). However, while, the subjective norms have a significant and substantial influence for women ($\beta=0.4$; $p<0.05$)., the subjective norms have a lower and insignificant influence for men ($\beta=0.15$; $p>0.05$).

Table 4-8: Linear regression - Willingness to participate by gender (standardized coefficients; robust standard errors)

	Male		Female	
TPB: Subjective norm	0.150	(0.113)	0.398*	(0.162)
TPB: Perceived behavioral control	0.372**	(0.112)	0.287*	(0.139)
TPB: Attitude	0.827***	(0.0933)	0.607***	(0.138)
Constant	-1.611*	(0.631)	-1.255**	(0.436)
Observations	187		108	
R-squared	0.48		0.54	

Standarderror in brackets; * p<0,05 ** p<0,01 *** p<0,001

4.3.3 Motivations and barriers to participate in RECs

Additionally, to the behavioral influence and according to the positive or negative indication of the willingness to engage or invest, the respondents were asked to indicate their primary reason why they would or would rather not actively engage or invest in a REC.

Motivations

For the general motivations, it can be said that climate protection (36% for active engagement and 40% for financial investment) and the contribution to the local distribution to renewable energy sources (30% for active engagement and 41% for financial investment) are the main reasons for participation in RECs. Financial (14%), and social (7%) motivations play a minor role. There are no statistically significant differences between the motivations among the income groups differences (p=0.783 for active engagement; p=0.716 for the financial investment). However, there are significant differences in the motivations between gender (p=0.00 for active engagement; p=0.00 for the financial investment). While women rather tend to choose global climate protection (60% for active engagement and 63% for financial investment) as the primary reason, most men set the local distribution of renewable energy (37% for active engagement and 49% for financial investment) as the primary reason (see Figure 0-5).

Barriers

Regarding the main barriers, the lack of time for active engagement (30%) as well as the lack of financial resources (30%) and information on RECs (24%) for the financial invests are the most predominant barriers. There are significant differences between the income groups for the barrier to active engagement (p=0.055) and the barrier to financial investment (p=0.00). For citizens from lower-income households, the lack of time (30% of the lower-income group) and skills (20% of the lower-income group), and the high bureaucratic effort (20% of the lower-income group) are the main barriers preventing active engagement (see Figure 0-6). Concerning the financial investment, the lack of money (65% of the lower-income group) is the central barrier for citizens from lower-income households (see Figure 0-7). The barriers are not significantly different between gender (p=0.324 for active engagement; p=0.541 for financial investment). However, it appears that apart from the lack of time and information, women also see the lack of skill (22% of women) as an essential barrier for an active engagement in RECs (see Figure 0-8).

4.4 Hypothesis testing

This study aims to learn about the influence of socio-psychological factors affecting the willingness to participate in RECs in Germany. In particular, the thesis analyzes the extent to which self-interest and moral considerations drive participation and how these influences differ among income groups and gender. Drawing from the theory, one can assume that the TPB

reflects self-interest based on (social) cost-benefit evaluations compared to the personal, which reflects moral considerations (Lindenberg & Steg, 2007).

As Figure 4-5 visualizes, the WTP is predominantly influenced by the attitude based on cost-benefit evaluations. However, also the social costs and benefits represented through the subjective norm play a significant role. Further, the perceived behavioral control significantly influences the WTP in RECs. Thus, the hypotheses under H1 can all be accepted for our sample. The effect of the personal norm is very small and insignificant, which at first leaves to the declination of hypothesis H2.1. However, as shown with a mediation analysis in the previous chapter, instead of a direct effect, the effect of the personal norm is mediated through attitude. From that follows, that the hypothesis H2.1 can partly be accepted for this sample as it does seem to influence the WTP in RECs, just not directly.

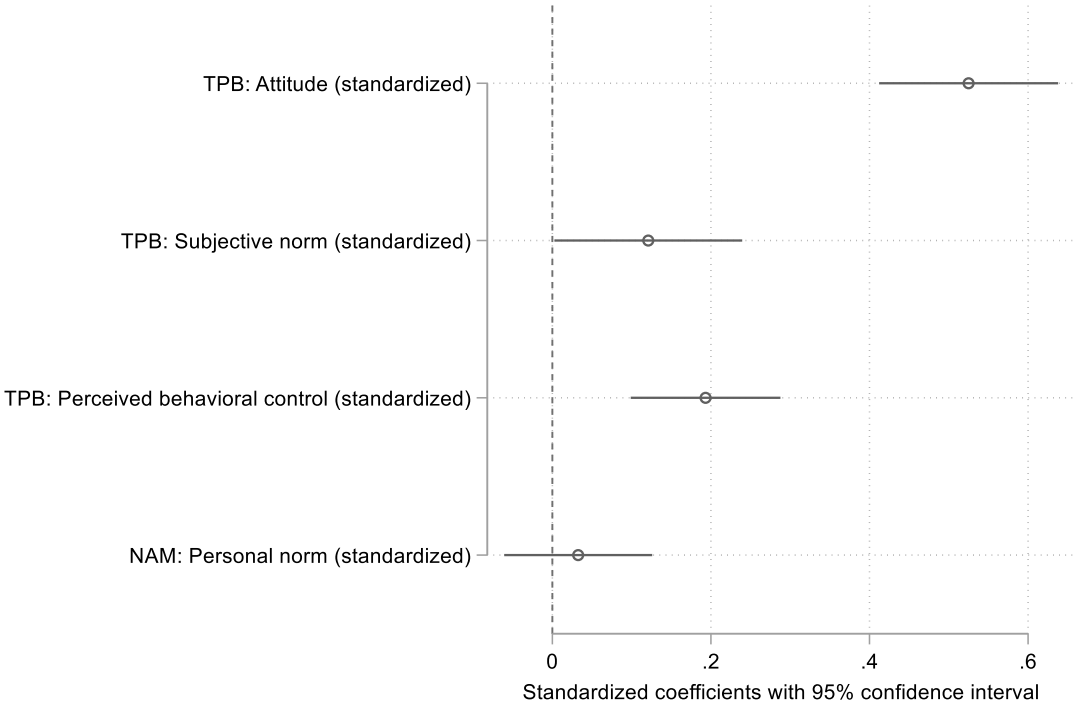

Figure 4-5: Influence of extended TPB determinants on the WTP

Due to the underrepresentation of lower-income groups and women within current RECs, group comparisons between income groups as well as between men and women were conducted. Firstly, differences between income groups were explored. Figure 4-6 shows the differences concerning the influence of TPB on the WTP in RECs. Over all groups, the attitudes based on the evaluation of costs and benefits have the biggest influence on the WTP over all income groups. However, the results suggest, that the WTP of lower-income groups is not significantly determined by social approval. Further, the influence of the perceived behavioral control (PBC) on the WTP is only significant for the higher income group.

Secondly, the results were analyzed regarding gender differences. It is important to mention though that within the sample there is only a minor, neglectable difference in the WTP between women and men (see Discussion). Figure 4-6 shows the differences in regard to the influence of TPB on the WTP in RECs. Although the evaluation of cost and benefits play a major role in determining the WTP, the influence of attitude is lower for women than for men. Instead,

women give more importance to social approval, whereas men are hardly influenced by the approval of significant others.

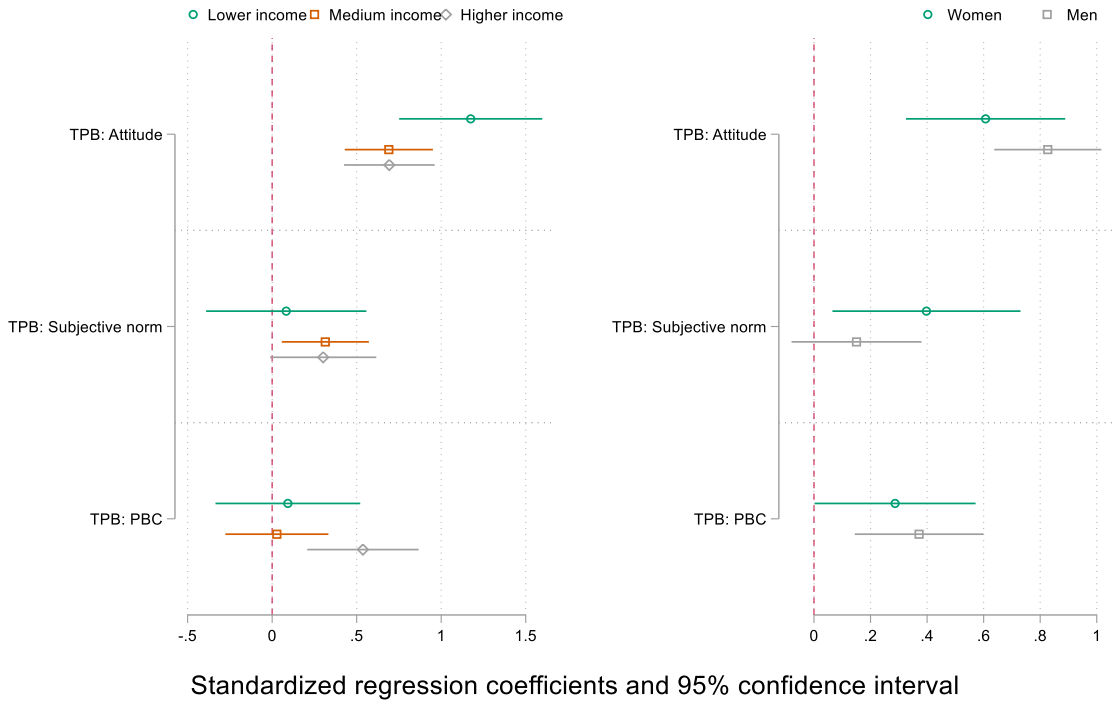

Figure 4-6: Influence of TPB determinants on the WTP by income and gender

Overall, the results concerning the established hypotheses are summarized in Table 4-9. While there are no differences in regard to the attitude, the influence of subjective norm on the WTP is low and insignificant for the lower income group and women. It is insignificant but substantial for the higher income group. The perceived behavioral control is lower and insignificant for lower and medium-income groups.

Table 4-9: Overview of hypotheses

Nr.	Hypothesis	Results Overall	Results by income groups	Results by gender
H1.1	The more positive the attitude towards RECs, the higher the WTP in RECs.	Yes* (sig.)	Lower: Yes (sig.) Medium: Yes (sig.) Higher: Yes (sig.)	Women: Yes (sig.) Men: Yes (sig.)
H1.2	H1.2: The higher the perceived subjective norm, the higher the WTP in RECs.	Yes (sig.)	Lower: No Medium: Yes (sig.) Higher: Yes	Women: Yes (sig.) Men: No
H1.3	H1.3: The higher the perceived behavioral control, the higher the WTP in RECs.	Yes (sig.)	Lower: No Medium: No Higher: Yes (sig.)	Women: Yes (sig.) Men: Yes (sig.)
H.2.1	The higher the personal norm, the higher the WTP in RECs.	Yes/ No (indirect, sig.)	-	-

*"Yes" if beta >0.1. "Sig." if effect significant (p<0.05).

5 Discussion

The previous chapter summarized the main empirical analysis. This chapter looks at the relevance of the findings in relation to the existing knowledge (5.1), discusses contextual and behaviorally informed strategies addressing socio-psychological aspects (5.2), and critically reflects on the limitations resulting from the methodology and the survey and sampling (5.3).

5.1 Relevance of findings

This thesis examined whether socio-psychological variables can explain the WTP in RECs. Drawing from two main socio-psychological theories, the extended TPB (by personal norm), was used to test the relationship between attitude, subjective and personal norms, perceived behavioral control with the WTP in RECs. This study analyzed the extent, to which the variables contribute to explain the WTP in RECs, and to what extent differences between income groups and gender exist.

5.1.1 Willingness to participate

The results suggest an overall positive willingness of the respondents to participate in RECs. However, the majority indicates opinions around the middle, which implies that they are undecided or do not have strong opinions (Kalkbrenner & Roosen, 2016). The moderately positive WTP - and it can be expected that the WTP translates only partly in actual behavior - is overall in line with the problem identified that citizen participation is not very high. The moderate indications can partly be explained by the fact that not everyone was previously aware of the concept of RECs. However, the positive indication and a rather positive attitude towards RECs suggest that there is interest and potential towards future RECs.

The respondents are slightly more willing to invest than to actively engage. Possible explanations can be drawn from the main indicated barriers. According to the indicated barriers, active participation seems to be perceived as time-intensive. Further, a Norwegian study has found that the likelihood for energy-saving behavior is lower due to procrastination – especially when the behavior appears to resource intensive (Lillemo, 2014).

5.1.2 The importance of socio-psychological determinants

How self-interest and moral considerations determine the WTP is discussed in the following.

Self-interest

Previous studies have shown the explanatory power of the TPB in regard to recycling intention, energy-saving, and other pro-environmental behaviors (Abrahamse & Steg, 2009; Botetzagias et al., 2015; Harland et al., 1999). Also in this study, the results suggest that the TPB model is useful in explaining the WTP in RECs. Based on the findings in previous literature, which found that behavior involving higher cost is well explained by the TPB, it can be assumed that citizens perceive the involvement as rather time, cost, or effort-intensive (Lindenberg & Steg, 2007). This aligns with the indicated barriers for active or financial engagement, meaning lack of time, money, and skills.

However, although the TPB predicts the WTP well and can explain half of the variance of the WTP, the other half is still unaccounted for. By way of example, the importance of habits and routine, which reflect the standard way of operating, have previously been emphasized concerning energy-related and other pro-environmental behavior (Shi et al., 2019; Steg & Vlek, 2009). Further, other contextual, personal, and attitudinal factors, that are not captured through the TPB variables might influence the WTP. For instance, community trust, environmental concern, and awareness, renewable energy acceptance have been found to

motivate participation in community energy projects (Boon & Dieperink, 2014; Kalkbrenner & Roosen, 2016; Koirala et al., 2018). However, hereof, the sufficiency assumption of the TPB must be considered (see Section 5.3.1).

More specifically, higher subjective norms and perceived behavioral control as well as a positive attitude towards RECs, are associated with a higher WTP. This supports the findings from Kalkbrenner and Roosen (2016), who previously emphasized the role of social norms in regard to the WTP in Germany. However, it also relativizes the findings by considering that the effect of attitude is still substantially bigger than the effect of subjective norms. This means, that although the social approval through important others has a significant impact, the evaluation of other costs and benefits through behavioral beliefs have a bigger influence. The significant effect of perceived behavioral control indicates that the WTP is influenced by internal and external control factors. While for active participation, internal factors play a big role, it seems that for financial participation, low-self-efficacy and external factors (e.g., policies, incentives, and socio-cultural factors) are determining the perceived behavioral control additional to internal factors.

Based on the results of the TPB model, it can be concluded that self-interest appears to play an important role in determining the WTP in RECs. However, self-interest is not only based on rationality and utility but also on social approval (e.g., social norms).

Moral considerations

Contrary to other studies finding additional explanatory power of personal norms on top of the TPB for energy-saving and other environmental behaviors, the results of this study show that personal norms do not additionally increase the explanatory power of the TPB model (Harland et al., 1999; Klöckner, 2013). Instead of a (significant) direct effect, which has been found concerning the recycling intention and other pro-environmental behavior intentions, the results of this study indicate that the personal norm only shows an indirect effect on the WTP (Botetzagias et al., 2015; Harland et al., 1999). The effect of the personal norm is mediated through the attitude – not through subjective norms as suggested by Thøgersen (2014). This however resonates with previous discussions concluding that there is no uniform empirical experience of how the NAM best fits into the TPB model (Botetzagias et al., 2015; Klöckner, 2013).

A possible explanation for the lack of a direct effect of personal norms compared to other behaviors could be that citizens, in general, have a low self-expectation (due to a low feeling of responsibility and problem perception) for the implementation of renewable energy technologies, as compared to for example recycling, and perceive that other actors should have a greater responsibility. In fact, a representative study on environmental awareness in Germany revealed that 70% of the respondents see the federal and state governments as main actors in the energy transition, followed by the individual citizen (48%), the industry (44%), and the energy sector (41%) (Umweltbundesamt, 2019).[21]

Based on the results of the extended TPB, it can be concluded that moral considerations indirectly influence the WTP over the attitude towards RECs but do not independently affect the WTP. The results suggest that the behavioral beliefs about the costs and benefits influencing the attitude are not only of rational nature but also include moral considerations. This is in line with the concept of bounded rationality, which limits the assumption that humans make

[21] The total percentage exceeds 100% as multiple answers were allowed.

decisions on purely rational grounds (Simon, 1990). Thus, strong normative beliefs can foster the WTP despite costs and effort (Steg et al., 2014).

5.1.3 Group comparison

Willingness to participate and socio-psychological determinants

The previous results emphasized the importance of attitudes, subjective and personal norms, and perceived behavioral control in determining the WTP in RECs. When looking at the differences in socio-psychological determinants among **income groups**, it is suggested that the perceived behavioral control of lower-income groups is significantly lower compared to middle/higher-income groups. Possible explanations can be drawn from the main indicated barriers of lower-income groups. Especially the skill and money were indicated as main barriers to active engagement and financial investment by lower-income groups. Thus, the difference could be related to a lack of self-efficacy (Bandura, 1986).

The differences in socio-psychological determinants among **men and women** suggest that the perceived behavioral control for women is significantly lower than for men. Possible explanations can be drawn when looking at the main indicated barriers of women. Especially the lack of time, skills as well as the lack of information was mentioned by women. Instead, the personal norm is significantly higher for women. This resonates with the general idea that the decision of women is for a big part influenced through the obligation to care and protect, while men base decisions rather on rationality (Gilligan & Wiggins, 1987).

The income group comparison confirms the homogeneity of membership and indicates that RECs continue to be an option for the rich, which currently goes against the aspiration of RECs as being inclusive, as suggested by the RED II. This undermines the concept of environmental justice, that the EU is pushing forward through, for example, the green new deal (Herman, 2015). The similarity of the WTP among women and men might be a sign of change but must be interpreted with high caution due to the non-representativity of the sample. Overall, these findings emphasize the need for target-specific strategies. The next section discusses the importance of determinants among the groups.

The importance of socio-psychological determinants

Although limited by methodological constraints (see Section 0), the separate linear regression gives an indication of the relative importance of the indicators. The results suggest that attitude is over all **income groups** the strongest predicter. While the subjective norm is an important predictor of the WTP for medium and higher-income groups, the subjective norm is not important for lower-income groups. Hence, one can assume that for citizens with lower income other issues are more important than the influence through peers.

Also among **gender**, the attitude remains the strongest predictor. However, whereas subjective norms have a lower and insignificant influence on the WTP for men, the results show that for women, subjective norms are a significant and strong predictor for the WTP additional to the attitude. This finding is in line with the notion that women are more receptive to social pressures or social issues than men (Hill & Lynch, 1983).

5.2 Intervention strategies

In the case of Germany, financial incentives through feed-in-tariffs were identified as the main driver for citizen energy. This has led to an increase in renewable energy technologies and made renewable energy more competitive with fossil-based energy. However, with the last changes in regulation, the number of RECs has been decreasing. This raises the question of which

strategies, in addition to financial incentives, can encourage inclusive participation in RECs., In the following, contextual as well as behaviorally informed strategies are discussed. While the former has the aim to change the contextual conditions, under which the individual decides to behave, the latter has the aim to change motivations, perceptions, and norms (Messick, 1983).

5.2.1 Contextual strategies

Contextual strategies include changes in the surrounding conditions. Especially when pro-environmental behavior is considered difficult due to costs and other hurdles, contextual changes can increase the attractiveness of the pro-environmental behavior (Steg & Vlek, 2009). Contextual changes may also have an indirect impact on perception and motivation (Steg & Vlek, 2009). This is important to notice, as the results of this study emphasize the importance of perceived behavioral control concerning the WTP. To guarantee high control beliefs among the citizens, it is important to ensure that perceived external factors favor participation in RECs. This is especially important as the translation of the WTP into actual participation further depends on the actual behavioral control (Icek Ajzen, 1991). By lowering the barriers through, for example, a national regulatory framework, multi-level-governance, and intermediary networks, the perceived and actual behavioral control might increase.

National regulatory framework

A national enabling framework is needed to ensure a high perceived behavioral control. By way of example, Docí and Vasileiadou (2015) emphasize the transitioning potential of RECs in the Netherlands but stress the need for further strengthening the network between relevant actors and a favorable regulatory framework. However, as discussed before in regard to the German regulatory system (see Section 2.1.2), the current form of the EEG rather poses hurdles than an enabling framework for co-ownership of renewable energy sources. The significant influence of perceived behavioral control on the WTP highlights the importance to adapt the EEG to the requirements of the RED II and establish an enabling framework supporting the development of RECs, by creating a level playing field, allowing energy sharing, and advocating citizen energy in urban settings through tenant electricity models. Using the example of bioenergy village[22] cooperatives in Germany, Roesler and Hassler (2019) explicitly emphasize the synergy of policies on various regime scales (national, regional, local) and in different sectors (energy and rural development) for a successful niche development.

Local governance

Therefore, local governance assisting citizens in the process of developing RECs is needed to increase the perceived behavioral control. The RED II explicitly mentions the role of municipalities as actors of RECs. In fact, the European Association of local authorities in energy transitions, *Energy Cities*, describes the role of municipalities as threefold (for more information and examples, see Bolle, 2019).

(1) **as regulatory and policy enablers** by, incorporating a community ownership goal into long-term environmental and energy policies, integrating citizens in urban planning, procuring locally produced energy, facilitating a network with European and national authorities as well as partnerships between urban and rural areas. For instance, as part of the long-term goal to be climate neutral, the city of Gent, Belgium defined a target of 15% of locally produced energy target by 2019. The German district of Steinfurt targets self-sufficiency through local energy

[22] Bioenergy village refers to a rural area, which collectively uses renewable biomass to generate heat and electricity.

consumption by 2050. Moreover, the Bristol Energy Company offers Purchase Power Agreements[23] for local community projects to ensure long and stable financing conditions.

(2) **as project partners or facilitators** by, setting up a dedicated body assisting energy communities, providing access to public facilities and funding as well as estimating potential and bringing citizens together. By way of example, the city Freiburg offers access to an online tool[24] to map the roofs of the city, which are suitable for solar PVs. In Frankfurt, 20 local citizens were able to set up a solar PV system on the roof of the public sports arena, which produces electricity for 60 households.

and (3) **as infrastructure operators** by, encouraging citizen participation within the local utility and advancing remunicipalization through citizens. Hereof, it is important to highlight the role of *Stadtwerke,* communal subsidiary utility companies providing public services (e.g., electricity, gas), which are typical within Germany. For instance, the *Stadtwerke* Jena encouraged the participation of citizens through cooperatives, which led to the acquisition of a 2% share through 1000 citizens. Moreover, a citizen cooperative in the city of Heßfurt managed to raise 1.5 million EUR to co-finance the takeover of parts of the distribution network.

In fact, it is emphasized that local authorities benefit from citizen energy – not least by contributing to the renewable energy and efficiency targets but also through fighting energy poverty, as RECs can provide lower tariffs for low-income households (Bündnis Bürgerenergie e.V., 2019). Next to the role of municipalities and local utility companies, it is important to underline the role of other local actors, such as small and medium-sized companies as well as housing cooperatives.

Networks and intermediaries

Furthermore, the role of intermediaries, in form of persons, but also public, private, and non-governmental organizations, who build a platform to exchange information and best practices is highlighted within the literature (Busch & Hansen, 2021; Ruggiero et al., 2019). For the United Kingdom, Seyfang et al. (2014) conclude on the need for policy support to establish intermediary organizations who can act as strengthening and knowledge-sharing platforms. Thereby, the role of intermediaries is often not to plan out the initiative but to open up "*space in different contexts (whether local, policy, market, social, etc.)"* (Hargreaves et al., 2013, para. 879). For instance, the European Energize Co2mmunity[25] project establishes Renewable Energy Co-operative Partnerships across the Baltic Sea Region to exchange experiences on coping with potentials and obstacles among different actors. REScoop.eu[26] is the European federation of citizen energy cooperatives with a network of 1500 cooperatives across Europe. In Germany, the Bündnis Bürgerenergie e.V. [27] is an example of an association that combines the interests of citizens.

5.2.2 Behaviorally informed strategies

Behavioral interventions are *"[i]nterventions designed to change behavior"* (Icek Ajzen, 2006a, p. 2) and can be achieved by addressing the determinants of behavior. Thereby, behaviorally informed solutions are interventions that are specifically based on previous evidence about the

[23] A long-term agreement between energy producer and purchaser (e.g, here the city) to purchase all of electricity. This becomes more important with the direct markting approach.

[24] https://www.freiburg.de/pb/,Lde/232537.html

[25] https://co2mmunity.eu/

[26] https://www.rescoop.eu/

[27] https://www.buendnis-buergerenergie.de/

determinants of a certain behavior (Sousa Lourenco et al., 2016). This study has identified several socio-psychological determinants of the WTP. The next step is to discuss practical implications and develop intervention strategies on how the determinants can be targeted (Steg & Vlek, 2009).

Ajzen (2006a) suggests considering the mean levels and relative weights (explained variance) among the TPB variables when choosing a determinant to target behavioral interventions (Icek Ajzen, 2006a). In the case of this study, the findings show that personal norms have the most room for change (mean=2.8). But the attitude toward RECs has the highest relative contribution, and thus, is more likely that the behavioral intervention will change the WTP. In the following, strategies addressing all four determinants are provided. The behaviorally informed strategies seek to alter the perceived personal capabilities, evaluation of costs and benefits as well as moral and normative concerns. Information, communication and framing, and capacity-building may raise awareness about energy-related problems and inform about choice options as well as positive or negative consequences (Steg & Vlek, 2009).

Information

The study showed that only 60% of the respondents were previously aware of the concept and that despite the overrepresentation of highly educated citizens. Thus, awareness-raising and education about RECs and related benefits and costs among citizens and other local actors could serve as a first step for increasing the participation of citizens. By way of example, already the distribution of this survey on Facebook and social networks achieved to call the attention of citizens towards the idea of RECs. This is emphasized by the high influence of previous awareness on the WTP in RECs found in this study.

The findings of this study further indicate that the personal norm is in general not very high regarding the participation in RECs among the respondents. The NAM suggests that the strength of personal norms depends on the ascription of responsibility and the awareness of consequences (Schwartz, 1968). Thus, enhancing the knowledge and awareness about energy and its environmental impacts as well as the feeling of responsibility through educational programs and awareness campaigns could lead to a higher self-expectation. It is critical to make the inconspicuous and intangible energy topic visible and comprehensible. Thus, it is especially important to integrate teaching about energy early on, for example in school education. It was shown how intergenerational learning can increase not only the children's but also the parents' concern about climate change. For instance, research has started to emerge estimating the influence of school-age children on their parents' concerns about climate change as well as recycling behavior (Denworth, 2019; MPMA, n.d.).

Communication and framing

Several strategies can be used to improve communication and framing. Firstly, to enhance the attitudes, the diversity of environmental, societal, and financial benefits and costs, as well as target-group specific benefits, should be communicated transparently and effectively. In this study, the results show that especially the global climate protection (for women) and the local distribution of renewable energy (for men) are considered as primary motivations. Further, as the participation is currently perceived as costly and resource-intensive, it is important that the variety of types of participation (i.e., cultural and social, political, and organizational, financial and economic), which demand varying degrees of time, financial resources, and previous knowledge, are presented.

Especially, when developing RECs, it is important to respond to the perceived barriers, such as time, financial resources, and skills, which were confirmed in this study. By way of example,

when communicating the concept of RECs, it can be pointed out that there are different legal forms, which have different benefits and costs. For instance, Consumer Stock Ownership Plans (CSOPs) is a form of trust scheme, which aims to include vulnerable households by offering low thresholds, such as low risks and commitments as well as low financial investments while enabling active decision-making (Jens Lowitzsch & Hanke, 2019).

Secondly, addressing subjective norms is a possibility to influence the WTP (Icek Ajzen, 2006a). The results showed that especially women and higher-income groups respond to subjective norms. Thereby, social norm marketing could be used by politics and practitioners to foster social expectations by sharing experiences of current members in RECs and *"telling people about what […] other people do [and approve]"* (Burchell et al., 2013, p. 1; Thøgersen & Grønhøj, 2010). Additionally, Lindenberg (2012) discusses how environmental cues, meaning triggers or information in the environment, affect normative behavior. As subjective norms are not necessarily visible, such as participation in RECs, McKenzie-Mohr (2000) emphasizes the importance of actively promoting and publicizing participation in sustainable activities. As mentioned in the previous Section, also communal goal-setting and commitments among the municipality can be used to increase the social pressure.

Next to the social expectations through subjective norms, the results indicated that also self-expectations through personal norms are an important (indirect) determinant of the WTP in RECs. Bolderdijk et al. (2013) found higher effectiveness of moral motives (such as protecting the environment) than of monetary motives (saving money) in environmental campaigning. Thus, communication campaigns could address the moral obligation regarding RECs, meaning by emphasizing the idea of *"acting appropriately […] benefiting other people, future generations, and the environment"* (Steg et al., 2014, p. 106). This, however, must be transferred to the participation in RECs which caution, as, based on the discussion earlier, it can be assumed that the participation in RECs is currently still perceived as rather time, resource, and skill intensive.

Capacity building

In regard to personal capacities, intermediary networks and municipalities can offer capability training to increase the cultural, social, organizational, and personal capacities on individual and community levels and thus increase the perceived behavioral control (Middlemiss & Parrish, 2010). This is especially important for the lower-income group and women who showed a significantly lower perceived behavioral control in this study (Chaskin, 2001; Middlemiss & Parrish, 2010).

5.3 Limitations

The results of this study are limited in several ways. How the general methodology, as well as the survey and sampling procedure, limits the results is discussed in the following sections.

5.3.1 **Methodology**

Firstly, it is important to mention that the study only captured and assessed the stated preferences about the intention to participate in RECs but not the actual or revealed preferences. The so-called *intention-behavior gap*[28] (Homer & Kahle, 1988; Sheeran, 2002) describes the phenomenon that although the intention to behave and the actual behavior are closely related, it only translates into actual behavior in a situation where the individual has control over

[28] Also referred to as value-action gap, attitude-behavior gap, etc. In this study, intention-behavior gap is used as it best reflects the behavioral intention, which is in the focus of this study.

and resources for the decision. Stern describes behavior as an *"interactive product of personal-sphere attitudinal variables […] and contextual factors […]"* (Stern, 2000, p. 405), and highlights, among others, the impact of laws and regulations, as well as personal capabilities and habits and routines. However, various studies previously indicated that the intention translated into behavior; a correlation of 0.47 has previously been identified (Armitage & Conner, 2001). In line with this theoretical limitation, that the intention rather captures an attitude towards behavior than the actual behavior, the methodological limitation questions the meaningfulness of the estimated model which is shown in this study by the high correlation between the willingness to participate and the attitude towards RECs (r=0.68).

Secondly, the TPB assumes that the attitude towards RECs results out of the assessment of costs and benefits. However, as around 40% of respondents from the study have not heard about RECs before and the study itself only gives a short (objective) introduction to RECs, it is unclear on what behavioral beliefs the attitudes are based on and how reliable the evaluation of costs and benefits and thus the indication of the attitude is. Since it is likely that only a subset of the actual costs and benefits are considered, it must be expected that the attitudes and their influence on the WTP can change over time and with the information respondents have. However, the analysis showed a significant influence of the attitude despite controlling for the previous awareness.

Thirdly, limitations in regard to the conceptualization of the TPB variables have to be made. Concerning the operationalization of subjective norms, Fishbein and Ajzen (2011) point out that the impact of subjective norms is commonly underestimated as only the injunctive (social) norms are measures. Based on the theory of normative conduct, an improvement could be achieved if also the descriptive norms were measured (Cialdini et al., 1990). Miniard and Cohen (1981) have criticized the conceptual and operational difference between normative and attitudinal beliefs (for an extensive discussion also see Fishbein and Ajzen (1981)). Also in this study, the two concepts were closely related (r=0.58), which leads to the fact that the effect of social norms is underestimated as it is partially mediated through attitudes.

Moreover, the question of sufficiency must be discussed. The TPB assumes that although variables may influence the intention of behavior, their effects on actions are mediated by the TPB variables. According to Ajzen and Fishbein (Icek Ajzen, 2005), other variables should only be included if the additional predictor increases the amount of explained variance. In this study, the personal norm did not add to the explained variance. Instead, the effect of personal norms is mediated by attitudes. Trafimow (2015) points out, however, that although the variables did not increase the unique variance, it is still important to consider as it explains how variance is produced.

Further, while the willingness to participate takes the active and financial participation into account, it does not explicitly include the participation to steer. This, however, is especially important when setting up RECs. It can be expected that the willingness to steer is lower as it takes more responsibility, time, and effort. For the Netherlands, Koirala et al. (2018) previously showed that the willingness to participate decreases with increasing organizational responsibility.

Finally, the results are limited regarding their casual inference as cross-sectional studies generally do not allow to make conclusions on the causality but the correlation between independent and dependent variables (Schnell et al., 2018). Although the mediation analysis statistically implies causality between personal norms and attitude, it cannot be assured with statistical methods as no temporal precedence is given (Roe, 2012).

5.3.2 Survey and sampling

The online survey research design and sampling design result in several biases, that must be accounted for. The implication of the biases on the results is discussed in the following in regard to the internal and external validity as well as construct reliability of the results.

External validity

External validity is defined as the degree to which the study results can be generalized to other persons and situations. A research design, therefore, has external validity, if the results obtained can be applied to the population as well as other people in other contexts (Schnell et al., 2018). As far as this study is concerned, the external validity faces limitations due to non-sampling, biases as well as a relatively low number of observations.

Due to the limited possibilities to distribute the survey as a result of the lack of resources (time and money) and the COVID-19 lock-down, an online survey research design and non-probability sampling are used. A fundamental challenge of non-probability sampling is that the results cannot be generalized to the population due to a lack of methodological representativity as the sampling demographics might be biased (Sue & Ritter, 2015). To test the representativeness of the sample, a comparison with the German population was conducted. It indicated that the sample was indeed not representative and can therefore not be generalized to the German population. The deviation of the population is especially problematic if the unobserved citizens differ regarding certain attitudes or characteristics from the observed citizens.

Additional to the non-probability sampling, the low representativeness must be discussed with respect to the selection bias (Couper, 2000). As citizens with high environmental concerns and a strong affinity or aversion to renewable energy technologies are more likely to fill in an online survey on the topic of RECs, the self-selection might have led to an over-representation of certain respondents. This is especially important to mention as the own extended network based on family and friends was addressed as part of the snowball sampling. The self-selection bias could also explain the difference in observations concerning gender (women n=108; men n=187; other n=3), as men show a higher interest in energy topics and Germany is still dominated by patriarchal structures. Therefore, it must be assumed that the sample's composition affected the findings, maybe resulting in a higher average WTP than what is true for the German population. Moreover, it is likely that stronger gender differences (e.g., in the WTP and perceived behavioral control) would have been found, if the sample had a higher representativity of the sample.

Moreover, limitations result out of the number of observations. The relatively small sample size (n=298) leads to several problems, which must be accounted for. As shown previously, it is important to emphasize that when conducting inferential tests with low sample sizes, the Type II error (i.e. false negative) increases (Prein et al., 1994). This can especially be a problem for the separate regressions for lower-income groups where the sample size is only 55. Further, despite the robust estimation of the standard error, outliers with high residuals can lead to under- and/or overestimation of the coefficients.

Taking the limitations in regard to the lacking representativeness and low sample size into account, it must be concluded, that the external validity of the findings of this study is highly limited.

Internal validity

Research is internally valid if trustworthy conclusions can be drawn from the results (i.e. it indicates if the research is sound and not subject to confounding factors) (Schnell et al., 2018). As part of this study, the internal validity might be restricted due to several measurement errors and constraints in the construct reliability.

Given the fact that the own extended network based on family and friends was addressed as part of the snowball sampling, the sampling error does not only have implications on the external but also the internal validity. Despite that the anonymity of the results is emphasized, it can be assumed that the familiarity between researcher and respondent can lead to social desirability in the response behavior, leading again to more positive responses. Other measurement errors can result due to other personal aspects, such as a lack of motivation, self-deception, and comprehension problems (Couper, 2000). This is especially problematic within self-administered online surveys where the absence of an interviewer can lead to a lack of control over the situation and thus lower quality of answers (Fowler, 2013).

Construct reliability

Furthermore, the construct reliability, meaning the extent to which the measure reflects the actual concept, must be reflected. To average out measurement errors and reflect the complexity of the socio-psychological determinants, the variables were captures with multiple items (Fowler, 1995). The overall construct reliability was moderate to high (Cronbach's α between 0.562 for personal norm and 0.89 for attitude variables). However, in the case of personal and subjective norms, low inter-item correlations (<0.2) led to the exclusion of one item. For the other variables, relatively high inter-item correlations (>0.4) indicate that the items capture only a very narrow perspective of the concept, which might result in a distortion of reality. In particular, the very high Cronbach's α for the attitude variables raised the question of whether the variables capture the complexity of the issue. The high inter-item correlations (>0.7) confirmed that suspicion. Instead of capturing the attitude only concerning the participation in RECs, it might have been better to include the general attitude towards renewable energy technologies.

Although the TPB variables and personal norms are based on established item batteries, it is further important to mention the general limitation of quantitative studies. Especially in regard to socio-psychological concepts, the numeric measurement of items is limited due to the difficulty of interpreting and translating the number into a narrative (Ho, 2017).

Acknowledging the limitations especially due to the external validity, the results must be interpreted cautiously. Although the sampling error does not allow generalization of the results, the conclusion of this survey can still be used as rough indicators for future research and policies as the results are valid when the sample is reflected. However, to increase the generalizability of the results, future research based on a representative probability sampling method is certainly needed.

6 Conclusion

Citizens have been identified as one of the main drivers of the energy transition in Germany. The European as well as German policy strategies addressing the low-carbon, decentralized energy transition both emphasize the role of Renewable Energy Communities (RECs) and its social, environmental, and economic benefits. The successful future implementation of renewable energy technologies through RECs is dependent on the active and financial participation of citizens. However, several changes in the energy policies in Germany have led to a decrease of newly registered RECs and so far, financial measures have failed to address vulnerable groups, which is reflected in the homogenous membership of RECs. This raised the question of which strategies, in addition to financial incentives, can encourage inclusive participation in RECs. To be able to enhance participation in RECs through contextual and behaviorally informed strategies, the factors determining the WTP need to be defined. The examination of the determining factors of the WTP gives behavioral insight, which then allows designing interventions to encourage participation in RECs.

6.1 Contribution of this thesis

The overall objective of this study was to develop an understanding of the socio-psychological determinants affecting the willingness to participate in RECs in Germany. Based on an online survey across citizens living in Germany, the influence of self-interest (represented through attitude, subjective norms, and perceived behavioral control; TPB) was tested. The willingness to participate was further examined via moral considerations (represented through personal norm; NAM) and the extent to which this could add explanatory power to the TPB. As low-income groups and women are currently underrepresented in RECs, special focus was given to the differences across income groups and gender.

In general, and with due limitations, the results suggest an overall positive willingness of the respondents to participate in RECs. However, the majority indicates opinions around the middle. In contrast to previous research, the respondents are slightly more willing to invest than to actively engage. Looking at the socio-psychological factors, the results indicate that the respondents have, on average, a positive attitude towards RECs and perceive rather high subjective norms (social expectations) and behavioral control regarding their participation. Those with relatively higher income as well as men perceive a higher control over their participation than lower-income groups and women. However, the respondents on average do not show a very high personal norm (self-expectation or experience of moral obligation) regarding their participation.

Regarding the RQ1 *"What influence does self-interest have on the willingness to participate in RECs in Germany?",* the following conclusion can be drawn. The self-interest reflected through the Theory of Planned Behavior has a rather high explanatory power, which indicates that participation in RECs is perceived as costly and resource-intensive behavior. The study confirms previous findings that the WTP is dependent on the social cost and benefits of RECs, anticipated through the social approval of relevant others. However, the evaluation of other consequences is more important. Additionally, the WTP is dependent on the perceived behavioral control. While internal, personal capabilities seemed to be determining active participation, self-efficacy and external factors seem to be additionally important for the financial participation. As the assessment of (social) costs and benefits influences the WTP, it can be concluded that self-interest plays an important role in the decision of whether to participate in RECs.

Concerning the RQ2 *"Additional to self-interest, what influence do moral considerations have on the willingness to participate in RECs?"* the thesis allows to conclude the following issues. The extension

of the TPB through moral considerations does not add any explanatory power. However, the results indicate that the assessment of general costs and benefits is itself partly related to moral obligations. From that follows that self-interest is not only based on rational considerations but also includes normative, moral considerations. This is in line with the concept of bounded rationality, which limits the assumption that humans make decisions on purely rational grounds. Additional to subjective norms, personal norms make people consider the appropriateness of their actions, in regard to other people, future generations, and the environment. The strong normative beliefs can foster the WTP in RECs despite costs and effort.

While there is a significant difference in the WTP between lower-income groups and middle and higher-income groups, no significant difference is found among women and men. Concerning the RQ3 *"How does the influence of self-interest and moral considerations on the willingness to participate in RECs differ between gender and income groups?",* the following conclusions can be made. The results indicate that the influence of social costs and benefits through social approval is less important for lower-income groups and men than for medium/higher-income groups and women. Nevertheless, attitude remains the most important determinant regarding the WTP across all analyzed socio-demographic and economic groups.

Overall, it can be summarized, that socio-psychological factors have an influence on the WTP in RECs. The results highlight the direct and indirect importance of self-interest and moral considerations as behavioral aspects. Devine-Wright (2007) even argues that increased awareness about the generation, supply, and distribution of energy gained through the participation in RECs could have a reinforcing effect by enhancing morally driven and self-interested energy behavior.

6.2 Practical recommendations and suggestions for further research

From a **policy perspective**, the results underscore the role of non-monetary, contextual, and behaviorally informed strategies to stimulate participation in RECs. Based on the identified socio-psychological factors of the WTP, videlicet self-interest, and moral considerations, the following recommendation for policy and practice encouraging the participation in RECs are proposed. Specifically, the findings suggest the importance of interventions that target the determinants attitudes, subjective and personal norms as well as perceived behavioral control. On one hand, structural strategies altering the contextual factors and thus enhancing the perceived behavioral control are suggested. Hereby, the role of multi-level governance with a legal regulatory framework on the national level and governance and intermediaries on the local and regional level are highlighted. Lowing the contextual barriers is especially important in light of the finding that participation in RECs is currently perceived as a demanding endeavor in terms of time, financial resources, effort, and skills.

On the other side, behaviorally informed strategies seek to alter the awareness, attitudes and activate subjective, personal norms and perceived behavioral control by providing information on and educating about RECs and energy-related environmental challenges, communicating, and framing the benefits and costs of RECs, and providing capacity building for low-income and women, who perceive a lower control over their behavior. The significant differences between income groups and gender concerning the influence of socio-psychological determinants highlight the importance of income and gender-specific measures to increase participation in RECs. From that follows, that the political actors in Germany should not only focus on transposing the Renewable Energy Directive (RED II) into the national legislation but simultaneously actively involve municipalities and intermediaries, raise awareness about RECs in the broad society and communicate its benefits.

From an **academic perspective**, the results contribute to the significant body of literature supporting the role of socio-psychological factors in energy citizenship, such as energy-saving, energy technology acceptance, and implementation. The results show the usefulness of TPB in explaining the WTP in RECs but also its limitations when researching attitudes with quantitative models. The differences across income groups and gender in socio-psychological determinants as well as in the influences of these factors on the WTP in RECs highlight the importance within behavioral studies and politics to take structural inequalities into account.

The following suggestions for further research are proposed. Several limitations – notably those associated with the sample - indicate further avenues for future research. In particular, the results are limited regarding their external generalizability. To improve the validity of the results, a comparison with a study based on a representative sample of the citizens living in Germany is recommended. Hereby, future studies could benefit from taking both types of social norms, namely injunctive and descriptive, into account. By using a mixed-methods approach, qualitative methods, such as interviews, could focus on the meta-analysis and give a deeper insight into the associated consequences of the participation in RECs. Therethrough, also the influences of behavioral, normative, and control beliefs on the attitude, subjective norms as well as perceived behavioral control could be captured (see Ajzen (2006b) for survey questions).

Moreover, as pointed out regarding the intention-behavior gap, this study focused on the willingness to participate but not the actual participation. This emphasizes the need for future studies assessing the linkage between stated and revealed preferences (e.g. Bamberg et al., 2015). Special attention must also be given to other factors influencing the WTP in RECs, such as contextual factors as well as habits and routines. Additionally, research and practice could benefit from studies evaluating the effect of the proposed contextual and behaviorally informed strategies. It would be interesting to analyze how certain strategies change the socio-psychological determinant and encourage the WTP as well as the actual participation in RECs. Experimental studies, such as randomized control trials, could be used to evaluate the interventions.

Future ambitions in practice, policy, and research regarding citizen participation in Renewable Energy Communities will not only allow to advance the energy transition but enable a just socio-technical transition.

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Appendix

Appendix A: Questionnaire

LUND UNIVERSITY

energiegemeinschaft → REC01 30.04.2021, 12:31

Seite 01

Lokale Erneuerbare Energiegemeinschaften in Deutschland

Guten Tag,

ich bin Anna, Masterstudentin an der Lund Universität in Schweden, und schreibe derzeit meine Masterarbeit zum Thema "**Erneuerbare Energiegemeinschaften in Deutschland**". Ziel dieser wissenschaftlichen Umfrage ist, mehr über die Motivationen und Barrieren von Bürgern in Deutschland bezüglich der Teilnahme an Erneuerbaren Energiegemeinschaften zu erfahren.

Zielgruppe sind alle Personen ab 18 Jahren, die in Deutschland wohnen. Als Dankeschön für Ihre Teilnahme werde ich im Rahmen eines **Gewinnspiels** fünf Deutsche Bahn Gutscheine (im Wert von jeweils 10 EUR; 5 jahre Gültigkeit) unter den Teilnehmenden verlosen. Die Beantwortung aller Fragen dauert **ca. 10 Minuten**. Es ist kein Vorwissen für diese Umfrage notwendig.

Ihre angegebenen Informationen werden **anonym** ausgewertet und ausschließlich für mein Forschungsprojekt verwendet. Ihre Teilnahme ist **freiwillig** und kann jederzeit beendet werden. Ihre Angaben werden streng vertraulich behandelt, ausschließlich für die Zwecke der Umfrage verwendet und nicht an Dritte weitergegeben. Mit dem Ausfüllen des Fragebogens erklären Sie sich einverstanden, dass Ihre Daten in der genannten Form verwendet werden dürfen.

Vielen Dank im Voraus für Ihre Unterstützung!
Anna Kracher

Bei Fragen bezüglich der Umfrage bin ich erreichbar unter: an4084kr-s@student.lu.se

Seite 02

Was sind lokale Erneuerbare Energiegemeinschaften?

In Erneuerbaren Energiegemeinschaften kommen lokale Bürger und Akteure (wie Kommunen und kleine, ortsnahe Firmen) zusammen, um gemeinsam in erneuerbare Energien zu investieren.

Beispielsweise können Mitglieder einer Energiegemeinschaft gemeinsam in die Errichtung von nahegelegenen Photovoltaikanlagen oder eines Windrads investieren.

Der erzeugte Strom kann von den Mitgliedern der Gemeinschaft selbst verbraucht und/oder verkauft werden. Dadurch werden gemeinsam Gewinne erzielt, die in der Gemeinschaft aufgeteilt werden. Die Teilnahme an einer Erneuerbaren Energiegemeinschaft bietet eine Möglichkeit, sich aktiv in den Prozess einzubringen und Mitsprache zu sichern.

Seite 03

Stellen Sie sich bitte für die folgenden Fragen vor, dass kürzlich in Ihrer Nachbarschaft eine Erneuerbare Energiegemeinschaft gegründet wurde.

		1	2	3	4	5	6	7	8	
Wie hoch wäre Ihre Bereitschaft, Geld in diese lokale Erneuerbare Energiegemeinschaft zu investieren?	sehr gering	○	○	○	○	○	○	○	○	sehr hoch

Seite 04

PHP-Code

```
if ((value('DV11_01') == 1) or
    (value('DV11_01') == 2) or
    (value('DV11_01') == 3) or
    (value('DV11_01') == 4)) {
  goToPage('barrier12');
}
```

Aus welchem Grund würden Sie (eher) in diese Erneuerbaren Energiegemeinschaft investieren?

Bitte wählen Sie Ihren Hauptgrund aus.

- ◯ Ich erwarte ökonomische Vorteile.
- ◯ Ich möchte zur lokalen Verbreitung erneuerbarer Energien beitragen.
- ◯ Ich möchte zum Klimaschutz beitragen.
- ◯ Ich möchte zur Gemeinschaft beitragen.
- ◯ Sonstiges, und zwar: [ ]

- ◯ weiß nicht

Seite 05

barrier12

PHP-Code

```
if ((value('DV11_01') == 5) or
    (value('DV11_01') == 6) or
    (value('DV11_01') == 7) or
    (value('DV11_01') == 8)) {
  goToPage('barrier13');
}
```

Aus welchem Grund würden Sie (eher) nicht in diese Erneuerbare Energiegemeinschaft investieren?

Bitte wähle Sie Ihren Hauptgrund aus.

- ◯ Ich habe kein Geld dafür.
- ◯ Ich habe nicht die notwendigen Fähigkeiten dafür.
- ◯ Sonstiges, und zwar:
- ◯ Ich habe keine Zeit dafür.
- ◯ Ich fühle mich ungenügend informiert bezüglich Erneuerbaren Energiegemeinschaften.
- ◯ Meine Sozialleistungen könnten sich durch zusätzliche Einnahmen reduzieren.
- ◯ Ich denke, dass der bürokratische Aufwand zu hoch ist.
- ◯ Ich glaube nicht, dass das Projekt profitabel ist.
- ◯ Ich bevorzuge eine konventionelle Energieversorgung.

- ◯ weiß nicht

Seite 06

barrier13

		1	2	3	4	5	6	7	8	
Wie hoch wäre Ihre Bereitschaft, sich aktiv in diese lokale Erneuerbare Energiegemeinschaft einzubringen?	sehr gering	◯	◯	◯	◯	◯	◯	◯	◯	sehr hoch

Seite 07

PHP-Code

```
if ((value('DV01_01') == 1) or
    (value('DV01_01') == 2) or
    (value('DV01_01') == 3) or
    (value('DV01_01') == 4)) {
  goToPage('barrier1');
}
```

Aus welchem Grund würden Sie sich (eher) aktiv in diese Erneuerbare Energiegemeinschaft einbringen?

Bitte wählen Sie Ihren Hauptgrund aus.

- ◯ Ich möchte zur lokalen Verbreitung erneuerbrer Energien beitragen.
- ◯ Ich möchte zum Klimaschutz beitragen.
- ◯ Ich möchte zur Gemeinschaft beitragen.
- ◯ Ich möchte mehr über Energie lernen.
- ◯ Ich möchte wissen, wo mein Strom produziert wird.
- ◯ Ich möchte finanzielle Vorteile genießen.
- ◯ Sonstige, und zwar: _____

- ◯ weiß nicht

Seite 08

barrier1

PHP-Code

```
if ((value('DV01_01') == 5) or
    (value('DV01_01') == 6) or
    (value('DV01_01') == 7) or
    (value('DV01_01') == 8)) {
  goToPage('barrier2');
}
```

Aus welchem Grund würden Sie sich (eher) nicht aktiv in diese Erneuerbare Energiegemeinschaft einbringen?

Bitte wähle Sie Ihren Hauptgrund aus.

- ◯ Ich bevorzuge eine konventionelle Energieversorgung.
- ◯ Ich glaube nicht an den Erfolg des Projektes.
- ◯ Ich habe nicht genug Zeit dafür.
- ◯ Ich denke, dass der bürokratische Aufwand zu hoch ist.
- ◯ Ich habe nicht die notwendigen Fähigkeiten dafür.
- ◯ Ich fühle mich ungenügend informiert bezüglich Erneuerbaren Energiegemeinschaften.
- ◯ Sonstiges, und zwar: _____

- ◯ weiß nicht

Seite 09

barrier2

In den nächsten Aussagen geht es um Ihre allgemeinen Einstellungen zu Erneuerbaren Energiegemeinschaften.

Inwieweit stimmen Sie den folgenden Aussagen zu?								
		1	2	3	4	5	6	
Ich fühle mich moralisch verpflichtet, an einer Erneuerbaren Energiegemeinschaft teilzunehmen.	stimme überhaupt nicht zu	○	○	○	○	○	○	stimme voll und ganz zu
Es liegt hauptsächlich an mir persönlich, ob ich an einer Erneuerbaren Energiegemeinschaft teilnehme.	stimme überhaupt nicht zu	○	○	○	○	○	○	stimme voll und ganz zu
Wenn ich nach meinen Überzeugungen handle, würde ich nicht an einer Erneuerbaren Energiegemeinschaft teilnehmen.	stimme überhaupt nicht zu	○	○	○	○	○	○	stimme voll und ganz zu
Ich bin überzeugt, dass ich an einer Erneuerbaren Energiegemeinschaft teilnehmen könnte.	stimme überhaupt nicht zu	○	○	○	○	○	○	stimme voll und ganz zu
Es wäre schwierig für mich, an einer Erneuerbaren Energiegemeinschaft teilzunehmen.	stimme überhaupt nicht zu	○	○	○	○	○	○	stimme voll und ganz zu
Ich habe die vollständige Kontrolle darüber, ob ich an einer Erneuerbaren Energiegemeinschaft teilnehme.	stimme überhaupt nicht zu	○	○	○	○	○	○	stimme voll und ganz zu
Ich fühle mich schuldig, wenn ich nicht an einer Erneuerbaren Energiegemeinschaft teilnehme.	stimme überhaupt nicht zu	○	○	○	○	○	○	stimme voll und ganz zu

Seite 10

Inwieweit denken Sie, dass								
		1	2	3	4	5	6	
... die Teilnahme von Bürgern an Erneuerbaren Energiegemeinschaften die Produktion erneuerbarer Energien beeinflusst?	sehr geringer Einfluss	○	○	○	○	○	○	sehr hoher Einfluss
... Ihre Teilnahme an einer Erneuerbaren Energiegemeinschaft die lokale Verbreitung erneuerbarer Energien beeinflusst?	sehr geringer Einfluss	○	○	○	○	○	○	sehr hoher Einfluss

Inwieweit stimmen Sie den folgenden Aussagen zu?								
Die meisten Menschen, die mir wichtig sind, ...		1	2	3	4	5	6	
... denken, dass meine Teilnahme an einer Erneuerbaren Energiegemeinschaft eine wichtige Sache ist.	stimme überhaupt nicht zu	○	○	○	○	○	○	stimme voll und ganz zu
... denken, dass ich gegen Erneuerbare Energiegemeinschaften sein sollte.	stimme überhaupt nicht zu	○	○	○	○	○	○	stimme voll und ganz zu
... würden meine Teilnahme an einer Erneuerbaren Energiegemeinschaft gutheißen.	stimme überhaupt nicht zu	○	○	○	○	○	○	stimme voll und ganz zu

Seite 11

Bitte vervollständigen Sie die folgenden Aussagen:

Ich denke, dass die Teilnahme an einer Erneuerbaren Energiegemeinschaft ... ist.

	1	2	3	4	5	6	7	
unwichtig	○	○	○	○	○	○	○	wichtig

Ich denke, dass die Teilnahme an einer Erneuerbaren Energiegemeinschaft ... ist.

	1	2	3	4	5	6	7	
nutzlos	○	○	○	○	○	○	○	nützlich

Ich denke, dass die Teilnahme an einer Erneuerbaren Energiegemeinschaft ... ist.

	1	2	3	4	5	6	7	
unklug	○	○	○	○	○	○	○	klug

Seite 12

Wie wahrscheinlich ist es Ihrer Meinung nach, dass a) oder b) in den nächsten 10 bis 20 Jahren aufgrund des aktuellen Energieverbrauchs auftreten wird?		1	2	3	4	5	6	
a) eine zunehmende Klimaerwärmung	sehr un-wahrscheinlich	○	○	○	○	○	○	sehr wahrscheinlich
b) eine zunehmende Luftverschmutzung	sehr un-wahrscheinlich	○	○	○	○	○	○	sehr wahrscheinlich

Wenn a) bzw. b) in den nächsten 10 bis 20 Jahren aufgrund des aktuellen Energieverbrauchs auftreten wird, wie groß wird das Problem Ihrer Meinung nach sein?		1	2	3	4	5	6	
a) eine zunehmende Klimaerwärmung	kein Problem	○	○	○	○	○	○	sehr großes Problem
b) eine zunehmende Luftverschmutzung	kein Problem	○	○	○	○	○	○	sehr großes Problem

Seite 13

Nun ein paar Fragen zu Ihrer Person.

Haben Sie vor dieser Umfrage schon einmal von dem Konzept „Erneuerbare Energiegemeinschaft“ oder ähnlichen Begriffen, wie „Erneuerbare Energiegenossenschaft“, gehört?

- ◯ Ja
- ◯ Nein

Sind oder waren Sie jemals Mitglied einer lokalen Erneuerbaren Energiegemeinschaft?

- ◯ Ja
- ◯ Nein

Seite 14

Wie alt sind Sie?

Ich bin ☐ Jahre

Was ist Ihr Geschlecht?

[Bitte auswählen]

Haben Sie Kinder?

- ◯ Ja
- ◯ Nein

Wie würden Sie Ihre aktuelle Situation beschreiben?

- ◯ Berufstätig
- ◯ Arbeitslos
- ◯ In Rente
- ◯ In Ausbildung (Schule, Studium oder Lehre)
- ◯ Sonstiges, und zwar: ☐

Seite 15

Welchen höchsten allgemeinbildenden Schulabschluss haben Sie?

Für einen Abschluss im Ausland, wählen Sie bitte einen vergleichbaren Abschluss aus.

- ◯ Kein Abschluss
- ◯ Volks-, Hauptschulabschluss
- ◯ Mittlerer Schulabschluss (z.B. Realschulabschluss)
- ◯ Fachhochschulreife (z.B. Abschluss von Fachoberschule)
- ◯ Abitur (Hochschulreife)
- ◯ Anderer Schulabschluss, und zwar: _____

Welchen höchsten beruflichen Ausbildungsabschluss haben Sie?

Für einen Abschluss im Ausland, wähle Sie bitte einen vergleichbaren Abschluss aus.

- ◯ Keinen beruflichen Ausbildungsabschluss
- ◯ Abgeschlossene Lehre (oder gleichwertiger Abschluss)
- ◯ Fachschulabschluss (Meister-, Techniker- oder gleichwertiger Fachschulabschluss)
- ◯ Fachhochschulabschluss
- ◯ Universität/Hochschulabschluss
- ◯ Promotion/Habilitation
- ◯ Anderer Berufsabschluss, und zwar: _____

Seite 16

Zum Schluss, ein paar Fragen zu Ihrem Haushalt.

Zum Haushalt gehören die Personen, mit denen Sie zusammenleben und gemeinsam wirtschaften, also große Ausgaben teilen.

Was beschreibt Ihre Wohnsituation am besten?

- ◯ Städtisch
- ◯ Ländlich

Wohnen Sie zur Miete oder im Eigentum?

- ◯ zur Miete
- ◯ im Eigentum

Wie viele Personen leben ständig in Ihrem Haushalt, Sie selbst eingeschlossen?

Bitte gib die Anzahl von Personen (einschließlich Ihrer Person) für die zutreffenden Optionen an.

- ☐ Kinder (unter 14 J.): ☐
- ☐ Teenager (14-17 J.): ☐
- ☐ Erwachsene (18 J. oder älter): ☐

Seite 17

Was ist das monatliche Netto-Einkommen Ihres Haushalts?

Gemeint ist der Betrag, der sich aus allen regelmäßige Einkünften zusammensetzt und nach Abzug der Steuern und Sozialversicherungen übrig bleibt. Bitte berücksichtigen Sie regelmäßige Zahlungen, wie Renten, Wohngeld, Eltern- und Kindergeld, BAföG, Unterszahlungen, Arbeitslosengeld und sonstige Einkünfte.

- ◯ Kein Einkommmen
- ◯ Weniger als 750€
- ◯ 750 € - 1000 €
- ◯ 1001 € - 1500 €
- ◯ 1501 € - 2000 €
- ◯ 2001 € - 2500 €
- ◯ 2501 € - 3000 €
- ◯ 3001 € - 3500 €
- ◯ 3501 € - 4000 €
- ◯ 4001 € - 4500 €
- ◯ 4501 € - 5000 €
- ◯ Über 5000 €

- ◯ Keine Angabe
- ◯ weiß nicht

Erhälten Sie derzeit Wohngeld, Sozialhilfe oder Arbeitslosengeld II?

- ◯ Ja
- ◯ Nein

- ◯ Keine Angabe

Seite 18

barrier3

Die Ergebnisse der Umfrage sollen u.a. nach dem Einkommen ausgewertet werden. Daher würde es mir bereits helfen, wenn Sie die grobe Einkommensgruppe nennen könnten, zu der Ihr Haushalt gehört. Ihre Angabe ist selbstverständlich vollständig anonym.

Die Frage lautete: Was ist das monatliche Netto-Einkommen Ihres Haushalts?

Gemeint ist der Betrag, der sich aus allen regelmäßige Einkünften zusammensetzt und nach Abzug der Steuern und Sozialversicherungen übrig bleibt. Bitte berücksichtigen Sie regelmäßige Zahlungen, wie Renten, Wohngeld, Eltern- und Kindergeld, BAföG, Unterszahlungen, Arbeitslosengeld und sonstige Einkünfte.

- ◯ Kein Einkommmen
- ◯ Weniger als 1000 €
- ◯ 1001 € - 2000 €
- ◯ 2001 € - 3000 €
- ◯ 3001 € - 4000 €
- ◯ 4001 € - 5000 €
- ◯ Über 5000 €

- ◯ Keine Angabe
- ◯ weiß nicht

Seite 19

barrier31

Bitte geben Sie hier die ersten drei Ziffern Ihrer Postleitzahl an.

- ◯ Postleitzahl [ ]

- ◯ Keine Angabe
- ◯ Ich wohne nicht in Deutschland.

Wie sind Sie auf diese Umfrage aufmerksam geworden?

- ◯ Ich bin Stromsparhelfer*in beim „Stromspar-Check".
- ◯ Ich arbeite anderweitig beim „Stromspar-Check".
- ◯ Ich bin über die „Stromspar-Check" Website auf die Umfrage gestoßen.
- ◯ Ich wurde vom „Stromspar"-Team beraten.
- ◯ Sonstiges

- ◯ keine Angabe

Seite 20

Vielen Dank für Ihre Bemühungen! Gibt es noch etwas, das Sie erwähnen möchten?

☐ Ich will am **Gewinnspiel** teilnehmen. Ich willige ein, dass meine E-Mail-Adresse bis zur Ziehung der Gewinner gespeichert wird. Diese Einwilligung kann ich jederzeit widerrufen. Meine Angaben in dieser Befragung bleiben weiterhin anonym, meine E-Mail-Adresse wird nicht an Dritte weitergegeben.

☐ Nach der Online-Umfrage werde ich eventuell detaillierte Telefon-Interviews zu der Motivation und den Barrieren für eine Teilnahme an Erneuerbaren Energiegemeinschaften durchführen. Wenn Sie an den Interviews teilnehmen möchten, Können Sie hier Ihre E-Mail-Adresse angeben. Die Kontaktdaten werden anonym und getrennt von den vorherigen Antworten erfasst.

Letzte Seite

Herzlichen Dank für Ihre Teilnahme!

Ihre Antworten wurden gespeichert, Sie können das Browser-Fenster nun schließen.

B.A. Anna Kracher – 2021

Appendix B: Operationalization

Table 0-1: Operationalization

Concept	Variables	Operationalization	Coding	Scale	Missings N = 298
Dependent variable					
Willingness to participate	2 items	Additive index of willingness to actively engage and invest	1 Very low … 8 Very high	Interval	
Willingness to actively engage	1 item				
Willingness to invest	1 item				
Central independent variables					
TPB: Attitude	3 items	Additive index	1 Very negative/low … 6 Very positive/high	Interval	
TPB: Subjective norm	2 items	Additive index			
TPB: Perceived behavioral control	2 items	Additive index			
NAM: Personal norm	2 items	Additive index			
Control variables					
Previous awareness	1 item		0 Yes 1 No	Nominal	
Age	1 item		19 … 78 years	Ratio	1 missings due to false value (x=1)
Gender	1 item		0 Female 1 Male (2 Others)	Nominal	
House ownership	1 item		0 Tenant 1 Ownership	Nominal	
Type of community	1 item		0 Urban 1 Rural	Nominal	
Education	2 items	CASMIN Scale (Brauns et al., 2003) based on highest school and vocational education	0 Low 1 Medium 2 High	Ordinal	

Table 0-1: Operationalization (Continuation)

Concept	**Variables**	**Operationalization**	**Coding**	**Scale**	**Missings** N = 298
Monthly household equivalent net income	2 items	The monthly net household income is used to measure the available income and is based on the assumption that income is shared within a household. The household's net income was captured in classes. For the transformation of the ordinal to metric scale, the mean of the class is calculated. The marginal highest/lowest classes are assigned 1.5/0.75 times the value of the lower/higher boundary. To calculate the equivalized income, the income is weighted against the composition of the household (GESIS, n.d.). **Weighting (based on OECD scale)** Weights based on the household members (for respondent: 1; every other member<14 years: 0.3; for members >= 14 years: 0,5) For more information see: (Destatis, n.d.) **Categories** • Lower income: <= 70% of the median income (here: <=1300 EUR); • Middle income: 70% - 150% of median income (here: 1300-3000 EUR); • Higher income: >= 150% of median income (here: > 3000 EUR); (Median income in 2019: 23 515; Source: Destatis (2019))	0 Lower income (primary and low secondary) 1 Middle income (middle, high secondary) 2 Higher income (low and high tertiary)	Ordinal	31 missings due to non-response

Appendix B: Findings

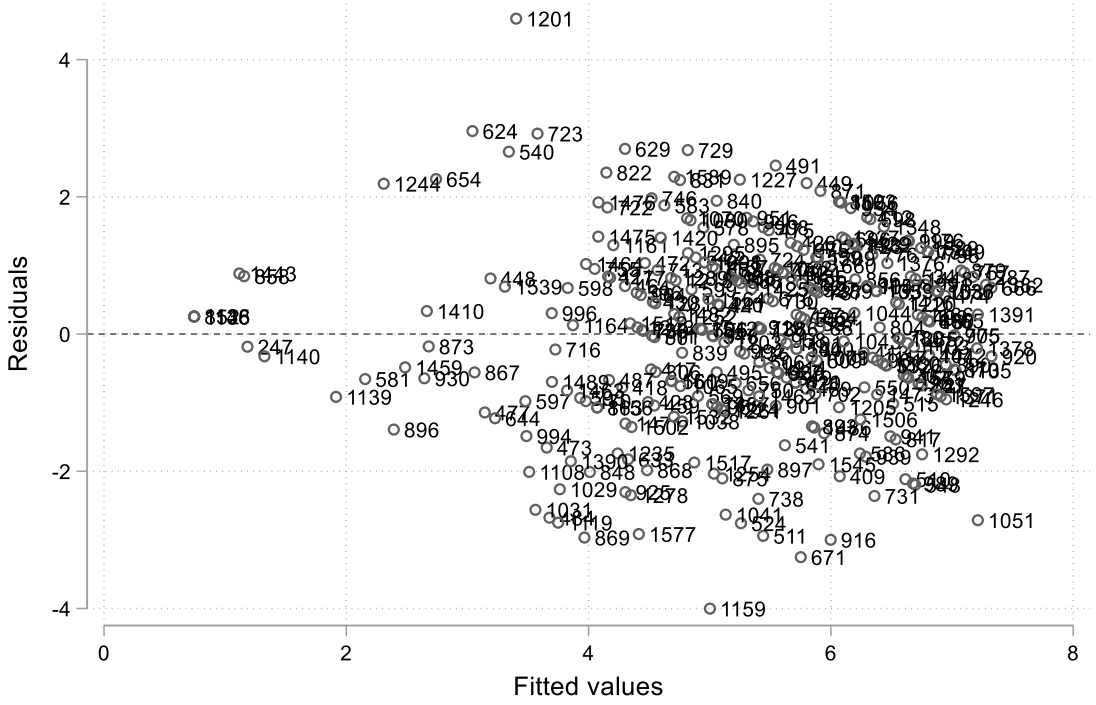

Figure 0-1: Residuals vs. fitted plot; extended TPB model (testing heteroskedasticity)

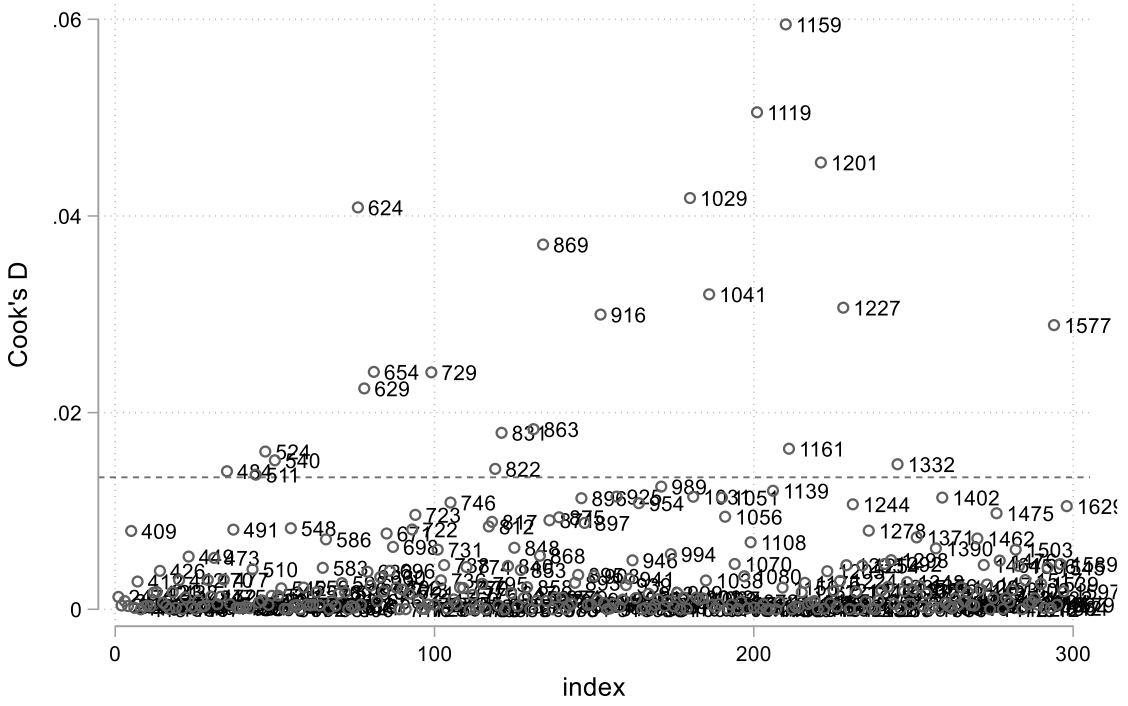

Figure 0-2: Cook's D; extended TPB model (testing outliers/leverage)

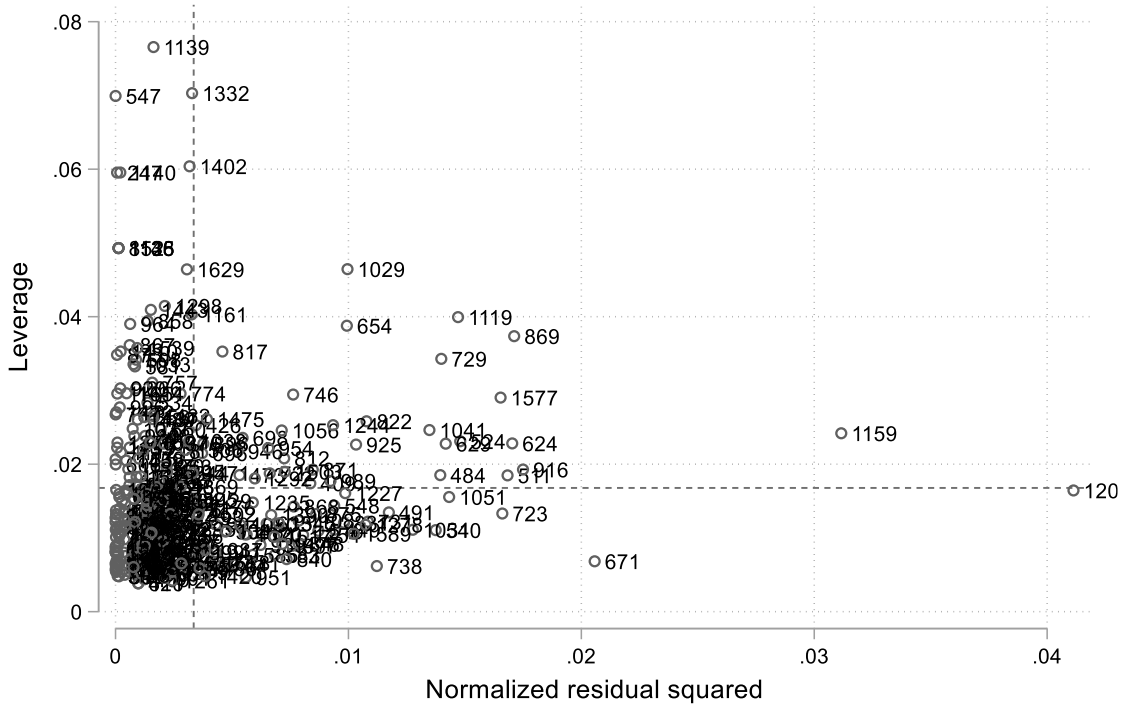

Figure 0-3: lvrplot; extended TPB model (testing leverage of residuals)

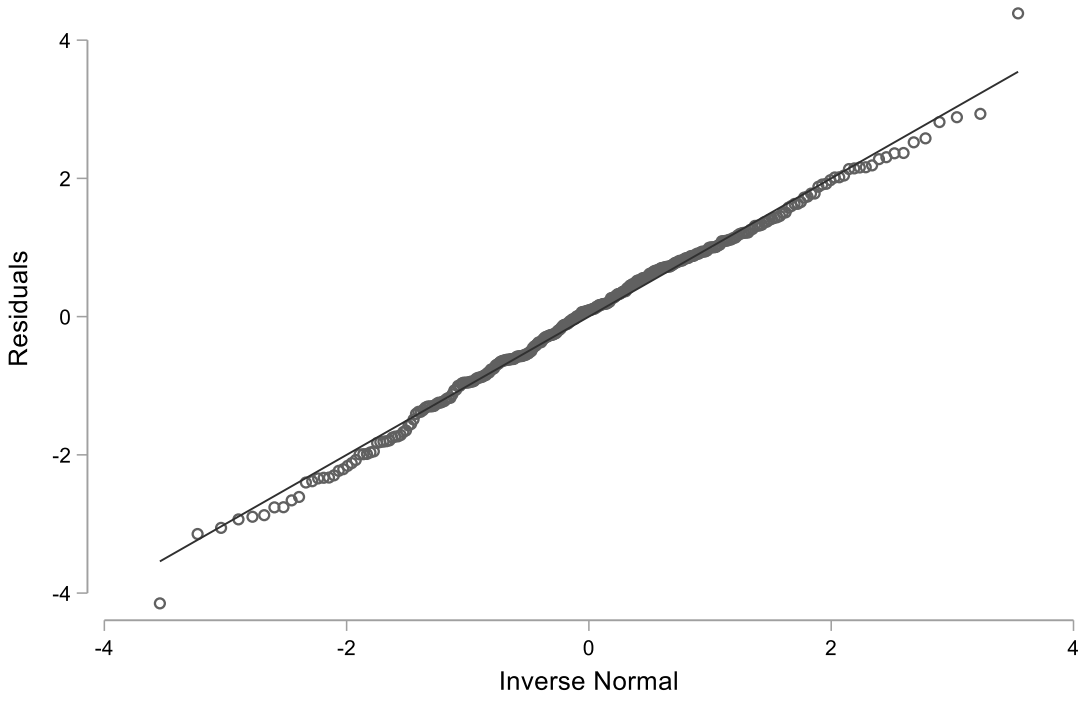

Figure 0-4: qnorm plot; extended TPB model (testing normal distribution residuals)

Table 0-2: Partial correlation analysis (using ranked variables)

Partial and Semipartial correlations of rnk_wtp_index with

Variable	Partial	SemiP	Partial^2	SemiP^2	Sig.
rnk_tpb_su~m	0.1488	0.1113	0.0222	0.0124	0.010
rnk_tpb_be~l	0.2495	0.1905	0.0622	0.0363	0.000
rnk_tpb_at~e	0.4240	0.3462	0.1798	0.1198	0.000
rnk_nam_pe~m	0.0245	0.0181	0.0006	0.0003	0.676

Table 0-3: Willingness to actively engage (unstandard. coefficients, robust estimation)

	Extended TPB		+ Control Var.	
TPB: Subjective norm	0.224*	(0.101)	0.248**	(0.0955)
TPB: Perceived behavioral control	0.344***	(0.0939)	0.156	(0.0952)
TPB: Attitude	0.744***	(0.0869)	0.750***	(0.0869)
NAM: Personal norm	0.0385	(0.0699)	0.0494	(0.0655)
Previous awareness (*Ref.: No*):			ref.	
Yes			0.744***	(0.176)
HH net-equiv. income (*Ref.: Low*):			ref.	
Medium income			0.793**	(0.252)
Higher income			0.720**	(0.275)
Gender (*Ref.: Female*):			ref.	
Male			0.0712	(0.175)
Other			-0.899*	(0.417)
Age			-0.00829	(0.00748)
Living area (*Ref.: Urban*):			ref.	
Rural			0.151	(0.172)
House ownership (*Ref.: Tenant*):			ref.	
Ownership			0.325	(0.203)
Education (*Ref.: Low*):			ref.	
Medium education			0.100	(0.346)
High education			0.121	(0.356)
Constant	-1.493**	(0.449)	-1.852**	(0.605)
Observations	266		266	
R-squared	0.50		0.58	

Ref. = Reference Category; Standarderror in brackets; * p<0,05 ** p<0,01 *** p<0,001

Table 0-4: Willingness to invest (unstandardized coefficients; robust estimation)

	Extended TPB		+ Control Var.	
TPB: Subjective norm	0.241*	(0.108)	0.282**	(0.107)
TPB: Perceived behavioral control	0.432***	(0.103)	0.246*	(0.104)
TPB: Attitude	0.732***	(0.0936)	0.750***	(0.0934)
NAM: Personal norm	0.0509	(0.0783)	0.0526	(0.0751)
Previous awareness (*Ref.: No*):			ref.	
Yes			0.567**	(0.212)
HH net-equiv. income (*Ref.: Low*):			ref.	
Medium income			0.859**	(0.299)
Higher income			0.756*	(0.317)
Gender (*Ref.: Female*):			ref.	
Male			0.0857	(0.214)
Other			-1.431*	(0.676)
Age			-0.0130	(0.00841)
Living area (*Ref.: Urban*):			ref.	
Rural			0.182	(0.194)
House ownership (*Ref.: Tenant*):			ref.	
Ownership			0.471*	(0.208)
Education (*Ref.: Low*):			ref.	
Medium education			0.0348	(0.490)
High education			0.227	(0.518)
Constant	-1.689***	(0.505)	-2.020*	(0.785)
Observations	266		266	
R-squared	0.45		0.53	

Ref. = Reference Category; Standarderror in brackets; * p<0,05 ** p<0,01 *** p<0,001

Table 0-5: Mann Whitney U test - Gender

```
. ranksum wtp_index, by(gender_test) exact

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

 gender_test |       obs    rank sum    expected
-------------+---------------------------------
      Female |       108       15089       15984
        Male |       187       28571       27676
-------------+---------------------------------
    combined |       295       43660       43660

unadjusted variance   498168.00
adjustment for ties    -3987.62
                     ----------
adjusted variance     494180.38

Ho: wtp_in~x(gender~t==Female) = wtp_in~x(gender~t==Male)
             z =  -1.273
    Prob > |z| =   0.2030
    Exact Prob =   0.2034
```

Table 0-6: Descriptive statistics - Independent variables by gender

	mean	sd	min	max
Female				
TPB: Attitude	5.620	1.264	1	7
TPB: Subjective norm	4.356	1.156	1	6
TPB: Perceived behavioral control	4.275	1.032	1.500	6
NAM: Personal norm	3.167	1.251	1	6
Male				
TPB: Attitude	5.560	1.300	1	7
TPB: Subjective norm	4.187	1.162	1	6
TPB: Perceived behavioral control	4.551	1.013	1.500	6
NAM: Personal norm	2.594	1.370	1	6
Total				
TPB: Attitude	5.582	1.285	1	7
TPB: Subjective norm	4.249	1.160	1	6
TPB: Perceived behavioral control	4.450	1.027	1.500	6
NAM: Personal norm	2.803	1.354	1	6

Table 0-7: Kruskal-Wallis test - WTP by Income groups

```
. kwallis wtp_index, by(kat_ainc)

Kruskal-Wallis equality-of-populations rank test
```

kat_ainc	Obs	Rank Sum
Lower income	55	5552.00
Medium income	121	17587.00
Higher income	91	12639.00

```
chi-squared =    13.055 with 2 d.f.
probability =     0.0015

chi-squared with ties =    13.158 with 2 d.f.
probability =     0.0014
```

Table 0-8: Descriptive statistics - Independent variables by income group

	mean	sd	min	max
Lower income				
TPB: Attitude	5.527	1.154	2	7
TPB: Subjective norm	4.264	1.122	2	6
TPB: Perceived behavioral control	3.836	1.116	1.500	6
NAM: Personal norm	2.827	1.438	1	6
Medium income				
TPB: Attitude	5.675	1.191	1	7
TPB: Subjective norm	4.347	1.056	1	6
TPB: Perceived behavioral control	4.597	0.939	2	6
NAM: Personal norm	2.893	1.273	1	5.500
Higher income				
TPB: Attitude	5.462	1.536	1	7
TPB: Subjective norm	4.071	1.324	1	6
TPB: Perceived behavioral control	4.668	0.946	1.750	6
NAM: Personal norm	2.621	1.385	1	6
Total				
TPB: Attitude	5.572	1.311	1	7
TPB: Subjective norm	4.236	1.169	1	6
TPB: Perceived behavioral control	4.464	1.028	1.500	6
NAM: Personal norm	2.787	1.347	1	6

Table 0-9: Dunn test - Willingness to participate by income (adjusted to Bonferroni)

```
. dunntest wtp_index, by(kat_ainc) ma(bonferroni)

Kruskal-Wallis equality-of-populations rank test
```

kat_ainc	Obs	Rank Sum
Lower income	55	5552.00
Medium income	121	17587.00
Higher income	91	12639.00

```
chi-squared =    13.055 with 2 d.f.
probability =     0.0015

chi-squared with ties =    13.158 with 2 d.f.
probability =     0.0014


           Dunn's Pairwise Comparison of wtp_index by kat_ainc
                                (Bonferroni)
Col Mean-
Row Mean |   Lower in   Medium i
---------+----------------------
Medium i |  -3.549587
         |     0.0006
         |
Higher i |  -2.888266   0.604975
         |     0.0058     0.8178
```

Table 0-10: Perceived behavioral control by income groups (adjusted to Bonferroni)

```
Kruskal-Wallis equality-of-populations rank test
```

kat_ainc	Obs	Rank Sum
Lower income	55	5012.00
Medium income	121	17208.50
Higher income	91	13557.50

```
chi-squared =    21.750 with 2 d.f.
probability =     0.0001

chi-squared with ties =    21.894 with 2 d.f.
probability =     0.0001
```

Dunn's Pairwise Comparison of tpb_behcontrol by kat_ainc
(Bonferroni)

Col Mean- Row Mean	Lower in	Medium i
Medium i	-4.081945 0.0001	
Higher i	-4.401235 0.0000	-0.633403 0.7897

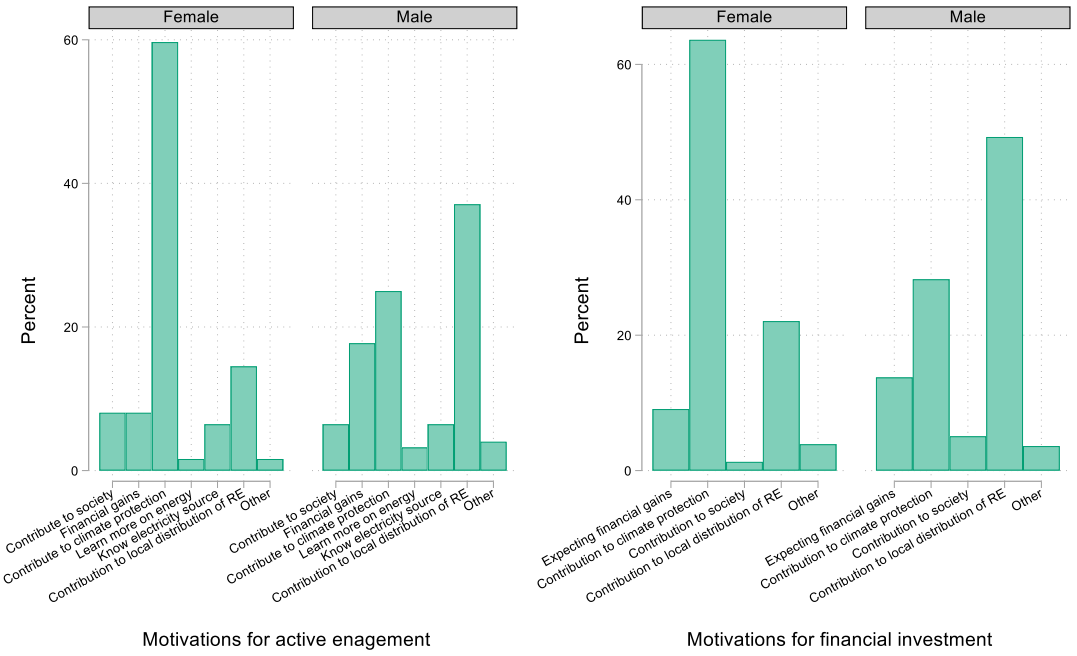

Figure 0-5: Primary motivations for active and financial participation by gender

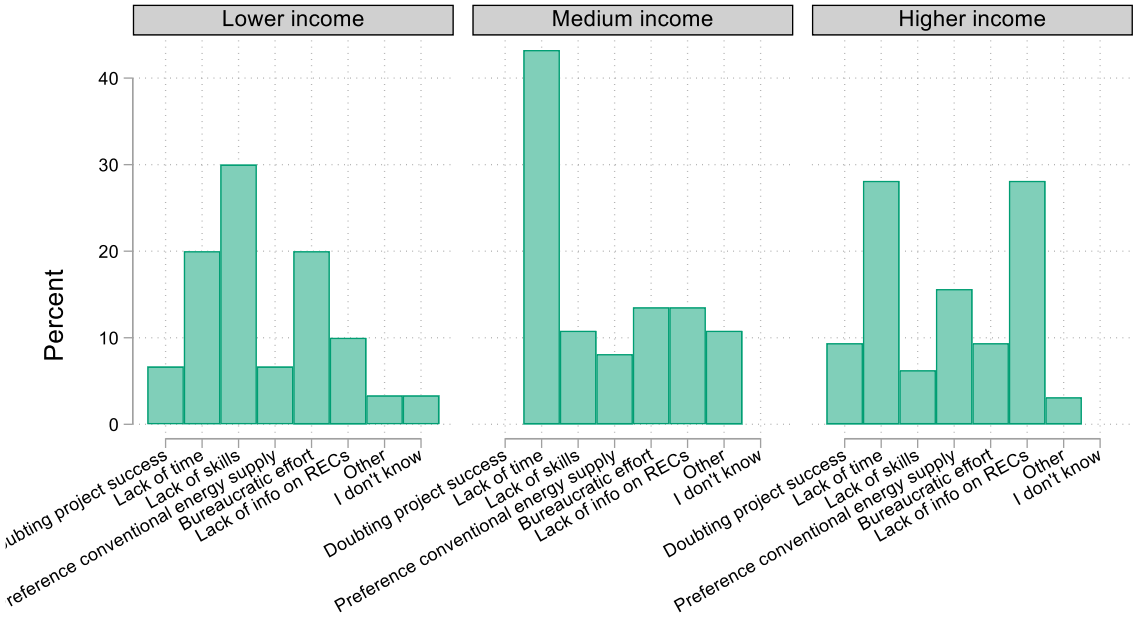

Figure 0-6: Primary barrier to the active participation by income group

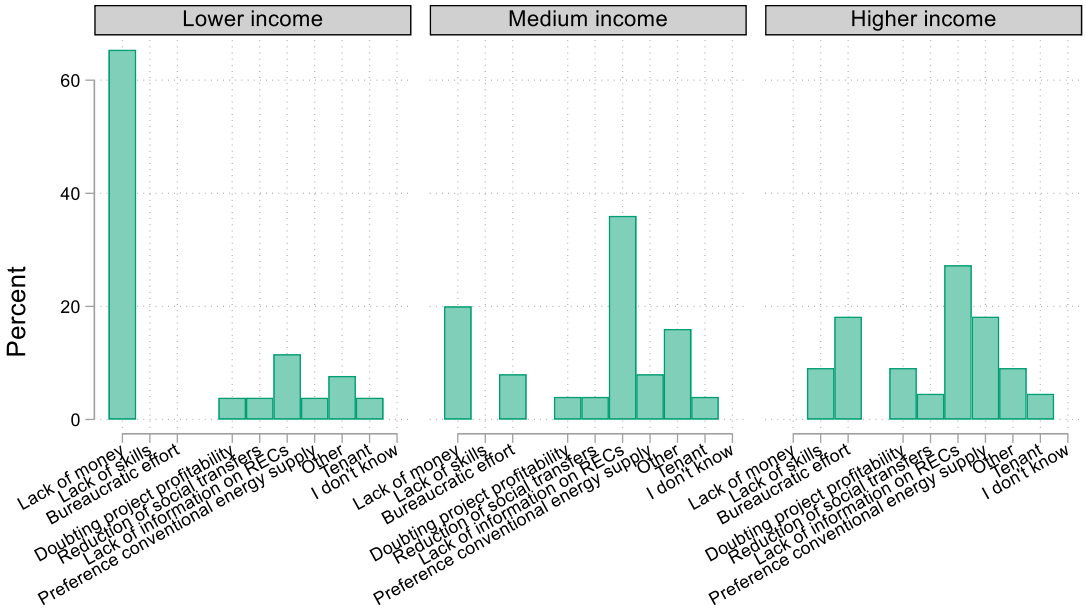

Figure 0-7: Primary barrier to the financial participation by income group

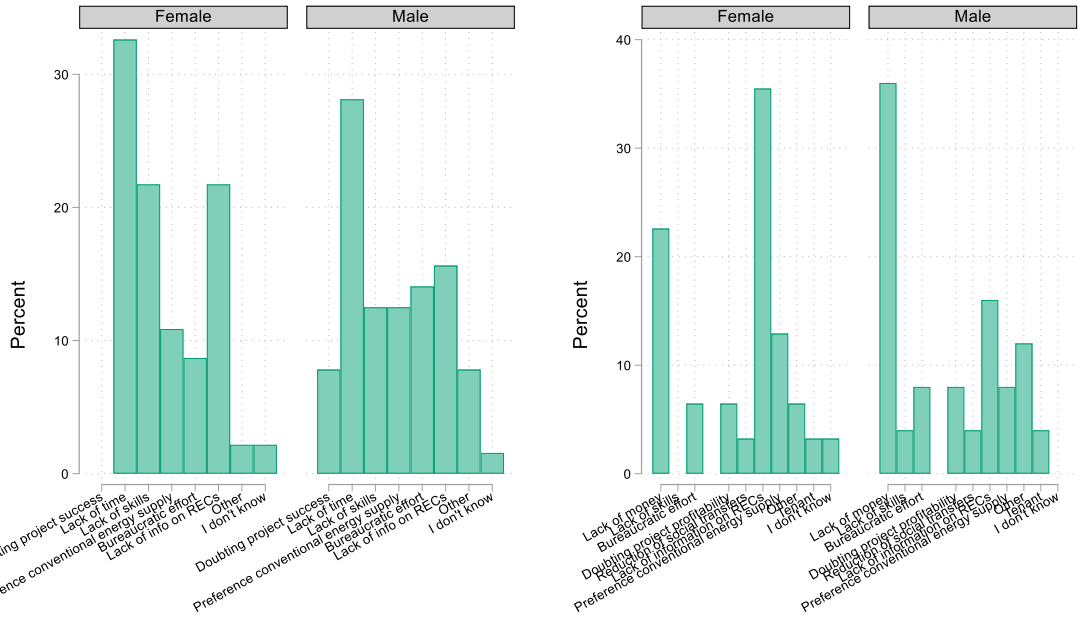

Figure 0-8: Primary barrier to the active and financial participation by gender