



Original research article

# Gender matters: Women, renewable energy, and citizen participation in Germany



Cornelia Fraune\*

University of Siegen, Research Centre "Shaping the Future" (FoKoS), Weidenauer Str. 167, 57076 Siegen, Germany

## ARTICLE INFO

### Article history:

Received 9 September 2014

Received in revised form 18 February 2015

Accepted 20 February 2015

### Keywords:

Energy transformation

Citizen participation schemes

Renewable energy production

Gender

Social context

## ABSTRACT

This study investigates how the larger social, cultural, and political context fosters and constrains citizens' agency to take part in citizen participation schemes in renewable electricity production (RES-E). Based on a comprehensive review of research on gender and energy, hypotheses about gender differences in involvement in citizen participation schemes in RES-E are derived. These are tested statistically on the basis of data gathered in the context of a pilot study. The results reveal differences between women and men in the average ownership rate of citizen participation schemes, the average investment sum and decision-making bodies. In contrast, findings on gender differences in the amount of capital assets invested per capita are inconclusive. This study gives an indication that beyond individual preferences and investment attitudes, cultural, social and political factors also influence an individual's agency to participate in RES-E operated by citizens' associations.

© 2015 Elsevier Ltd. All rights reserved.

## 1. Introduction

The article analyzes how the larger social, cultural, and political context fosters and constrains people's agency to take part in citizen participation schemes in renewable electricity production (RES-E) by exploring differences in women's and men's involvement in ownership, investment sum and decision-making bodies. The article shows that these differences cannot be explained alone by individual preferences and attitudes but have to be traced back to social conditions like gender, wealth gap, occupational segregation, or tax legislation.

Against the background of climate change and energy security concerns, governments across the globe face the challenge of transforming their national energy systems [1]. Albeit not undisputed in terms of feasibility, RES-E is assumed to be a key technology to meet this challenge, especially in Europe [2]. In this respect, citizen participation schemes within RES-E have gained political as well as academic attention, since these are considered to overcome infrastructural and economic path dependency of large fossil energy systems ([3], p. 1). Moreover, citizen participation schemes are discussed as funding sources of transformations beyond

government and business [4,5] as well as an instrument to foster energy transformations by enhancing public acceptance [6–8].<sup>1</sup>

Citizen participation schemes in RES-E are characterized by both decentralization and the congruence of investment and possession. Ideally, local citizens are the driving force in each step of the plants' realization: planning, mobilization of resources and its operative implementation ([4], p. 573; [3], p. 2). Therefore, citizen participation in RES-E serves as a reference point of energy transformations defined as "significant transformations in socio-energy systems" ([15], p. 32). The control of the energy sector changes from some large private or government-owned utility companies to a more heterogeneous group of producers [9,10].

These transformation processes stress the need for social science's energy research for its own sake and not for being "adjutants in the introduction of new energy technologies" ([11], p. 24). Social science research on energy has a long tradition. Early research assumed that socio-economic progress is dependent on methods and techniques of energy supply [12]. Post-war research

<sup>1</sup> Although both terms transition and transformation are used as near-synonyms, slight differences in content exist. Transformation research usually analyses energy-related changes against the background of broader social processes. Transition research in contrast is often focused on energy as the dominant topic. Moreover, these analyses often originate from normative concerns about sustainability ([66], p. 720; [69]). Against this background, the term transformation is used within this paper.

\* Tel.: +49 271 740 3846.

E-mail address: [cornelia.fraune@uni-siegen.de](mailto:cornelia.fraune@uni-siegen.de)

abandoned this deterministic assumption and started to ask about social influence on the development of energy supply [13,14]. Shove and Walker [83] show how research diversified according to the factors that both determine and are determined by the evolution of energy systems – for example the economic system or politics. Against this background, they criticize current energy research for not being able to grasp the complexity of energy-society relations since most of the approaches are focused on one factor, e.g. technological innovation or economic progress [83]. Sovacool provides an overview of current social science energy research and argues likewise for an integrated interdisciplinary research in order to advance energy analysis [61].

Miller, Richter and O’Leary [15] recently pointed out that more attention has to be paid to the dynamics and interdependencies within socio-energy systems since energy transformations are not only about changing technologies but about changing society ([15], p. 31). Referring to both current demand for consolidating social sciences’ energy research as well as current findings, this paper argues that research on citizen participation schemes in RES-E needs to integrate a social science perspective since the larger social, cultural, and political context shape individuals’ agency to participate and thus social outcomes. Basic assumptions of research about citizen participation schemes have so far been public support of RES-E as a matter of principle, independent of country-specific contexts [16] as well as the egalitarian democratic ideal assuming “that citizens from different social groups – such as men and women, the rich and poor, and the highly and less well educated – are equally likely to participate in associational life” ([17], p. 302). Some empirical evidence refutes this assumption. Individuals participating in RES-E differ in regard to sex, education, age, etc. [4,18,19].

Within the RES-E literature, investors have been characterized as rational, rent-seeking agents [2,5]. More recently, this assumption has been challenged. The relevance of non-financial factors like personal characteristics and attitudes as well as influence of peers or consultants affecting investment decisions has been discussed [4,2]. The aim of this paper is to enhance this research by explaining how the larger social, cultural, and political context fosters and constrains citizens’ agency to participate in RES-E. Thus, the paper is not focused on the individual investor’s decision-making process but starts one step before and explores the impact of the larger context on individuals’ agency and capabilities to participate.<sup>2</sup> The starting point of investigation is empirical evidence showing that an overwhelming majority of participants are men ([19], p. 64). In referring to gender and energy literature the paper points out that this unequal gender ratio can be explained by regulation and norms, i.e. the gender regime [20,21,67].

A pilot study on women’s and men’s participation in German citizen participation schemes in RES-E is conducted in order to explore the influence of regulations and norms on the gender ratio. Within the domain of research on citizen participation schemes, Germany is often chosen as a reference point in academia as well as in politics [3,9,19,22–24,81]. Compared to other countries, the German government not only subsidized citizen participation schemes in RES-E at an early stage, but was and still is quite successful in implementing high installed RES-E capacity as well as in developing citizen participation as a source of funding. The specific outcomes of the interdependencies between the institutional and cultural contexts and the gender ratio in citizen participation schemes are of course only valid in the German context. But the causal mechanisms

between context and individuals’ agency and capabilities to participate remain valid for all contexts. Thus, in principle the paper’s argument could be applied anywhere.

The article proceeds as follows. First, the methodological approach will be explored. Therefore, the scope and aim of a pilot study will be discussed. Moreover, the choice of *t*-tests for analyzing the empirical results will be reasoned. In order to explain case selection as well as conditions of data gathering, characteristics of citizen participation schemes in RES-E in Germany will be presented. Then, details of data gathered will be outlined. Afterwards, the analytical approach will be developed by reviewing research on gender and energy. Against the background of this review, hypotheses about gender differences in involvement in citizen participation schemes in RES-E will be advanced and statistically tested. Finally, the results will be discussed in light of the cultural, social and political context of citizen participation schemes in RES-E.

## 2. Research methods and country background

The aim of this paper is to identify causal mechanisms between the gender regime and women’s and men’s involvement in citizen participation schemes in RES-E. In order to analyze causal mechanisms, hypotheses are derived by presenting a review of the literature on gender and energy. These hypotheses are tested on the basis of empirical evidence generated by a pilot study of gender relations within citizen participation schemes in RES-E in Germany. A pilot study, as understood in this paper, has many features in common with a case study [25]: in choosing Germany as a case for citizen participation schemes in RES-E, a single-unit analysis is conducted with citizen participation schemes operating wind or solar power plants representing cases. The term pilot study indicates that the case represented is of a rather exploratory nature since a new phenomenon [26] or a new perspective on existent evidence [27] is presented. The pilot study conducted in this paper belongs to the latter group.

In order to determine if women’s and men’s participation rates in citizen participation schemes are statistically significant *t*-tests are conducted. Due to difficulties in the context of data collection that will be explained in more detail in Section 2.2, the sample is rather small. The sample size influences the unambiguous interpretability of significant and non-significant results. In general, a significance level of 0.05 is applied in *t*-tests (Type I error probability). This rather conservative significance level might implicate that in terms of small samples the null hypothesis is confirmed erroneously (Type II error probability). In order to prevent misjudgment, power *t*-tests are also applied to those results that are significant only on a 0.1 level. In general, a level of type II error probability of 0.1 is accepted, thus a power of test level falling below the 0.9 level is not accepted (Power of test = 1 minus Type II error probability). If both the level of significance and power of test are not accepted, the results could not be interpreted reliably [28]. Within these cases, results have to be interpreted in terms of the broader content and the other results.

*T*-tests are based on the comparison of the mean of different subsamples. Hence relying only on the mean may lead to misjudgments because the empirical distribution is not considered. Especially in small-*n* designs, the identification of outliers and the proportional distribution of the quartiles are regarded as crucial. Therefore, boxplots are used to visualize the results of the *t*-tests.

The aim of this study is not to prove a causal relationship between gender regime and gender ratio in citizen participation schemes but to explore causal mechanisms between gender regimes and the unequal gender ratios within citizen participation schemes. Moreover, this pilot study indicates that further gender

<sup>2</sup> The term capabilities is applied in reference to the capability-approach developed by Sen. According to this approach capabilities represent an individual’s freedom to choose between alternative ways of living ([82], p. 95).

as well as social science research in general on citizen participation schemes in RES-E is needed.

### 2.1. Citizen participation schemes in RES-E in Germany: scope and history

Germany has taken a pioneering role in both capacity of RES-E as well as its shares owned by citizens. In 2013, Germany has installed the most capacity of solar PV globally (36 gigawatt) and after China and the United States the most capacity of wind power (31,270 megawatt) [22,29]. It is estimated that private persons are the largest group of owners in regard to both photovoltaic (39.3 percent) as well as onshore wind (51.5 percent) [30]. Moreover, compared to other countries citizen participation models are not constrained to a certain renewable energy resource like wind power but are diversified to many resources ([3], p. 9). Wind and solar power are the most prominent renewable energy resources in regard to citizen participation [30].

The comparatively successful implementation of renewable energy capacity by citizen participation has been ascribed to the “Renewable Energy Feed-in Tariff” implemented by the Act on the Sale of Electricity to the Grid in 1991 that ensured operators of renewable electricity plants fixed electricity sales prices. In 2001, this Act was replaced by the Renewable Energy Law (EEG) [31,73]. It is argued that the German feed-in tariff scheme “emphasises competition, opportunities for smaller market players against monopolistic practices, and the internalization of external costs” ([24], p. 685). According to the World Energy Outlook 2014, Germany has paid the most subsidies on renewables for power generation in 2013 globally ([22], p. 276–7).<sup>3</sup>

Moreover, citizen participation schemes in RES-E had been the driving force behind the development and diffusion of renewable electricity production in Germany. In the 1970s and 1980s, conventional industry was not interested in renewable energy although the government had addressed promoting schemes to them. At the same time, small wind power plants were built and operated by ideologically motivated individuals engaged in the environmental movement. Since wind power plants are quite capital-intensive, individuals pooled financial resources in order to realize alternative energy production ([32]; [78], p. 47–58). At the end of the 1980s the German government changed its promoting schemes by tailoring them to small wind power operators instead of to industry and implemented the feed-in tariffs explained above. Due to its pioneering role, the German case serves as a reference point in revealing the impact of the larger social, cultural and political context on citizens’ capabilities to participate and thus to benefit from citizen participation schemes in RES-E. These interdependencies between the larger context and both individuals’ capabilities to participate as well as social outcomes are not only relevant in the German context but in all national contexts implementing citizen participation schemes in RES-E.

### 2.2. Data gathering

The major challenge has been to identify renewable energy plants owned by citizens since official statistics about renewable energy plants are rather incomplete in Germany. This is quite remarkable since one of the three main aims of the German Energy Transformation is to provide the bulk of electrical power supply by renewable energy resources in the foreseeable future. According

to the Renewable Energy Law (EEG) operators of renewable electricity plants have to provide information about their plants. This information is published by transmission system operators. Beyond several problems of data processing, our main problem with these data is that they do not reveal any information about the plants’ ownership structures. In consequence, it is not feasible to differentiate between renewable electricity plants operated by business or by civil society on the basis of available official data. In order to solve the lack of empirical data a pilot study was conducted by collecting evidence about women’s and men’s involvement in citizen participation schemes in RES-E.

In order to keep this inquiry manageable the investigation was narrowed to a region called South Westphalia where most of the renewable electricity is provided by wind and solar power. It is located in North-Rhine-Westphalia (NRW), one of 16 German federal states. Since the mid-1980s, renewable energy has been promoted quite successfully by the North Rhine-Westphalian state government. Its policies served as a model for both other federal states as well as the federal government [6,86]. A twofold strategy was adopted to gather the information needed. On the one hand, available databases were scanned in order to identify renewable energy plants: the company database provided by the Siegen Chamber of Commerce and Industry (IHK Siegen) and the List of Power Plants (Kraftwerksliste) provided by the Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway (Bundesnetzagentur). Moreover, I got in touch with the regional association South Westphalia of the German Wind Energy Association (BWE) as well as with well-known agents of local citizen participation schemes in order to identify the renewable energy plants in question from the data gathered. Furthermore, information about citizen participation schemes was collected in the archives of local newspapers. In this way, 38 citizens’ associations operating wind power plants and 33 citizens’ associations operating solar power plants were ascertained.

Next, I got in touch with the chief executive or board member by mail or by e-mail in order to get information about the participants’ gender ratio within each plant. I asked the following questions:

1. How many institutional investors like companies or municipalities have a share in the renewable energy plant?
2. How many women have a share in the renewable energy plant?
3. How many men have a share in the renewable energy plant?
4. What is the total investment volume?
5. What amount of the total investment volume is provided by women?
6. What amount of the total investment volume is provided by men?

Thus, I was dependent on the cooperativeness of the power plant officials. Although these wind and solar power plants all have in common that they are operated by a citizen association, they are quite different. In regard to data gathering, the different types of local citizen investors are of special importance [9]. Twenty-seven of the citizens’ associations engaged in wind power were developed and operated by a professional project developer. This professional developer was not willing to cooperate. Thus, eleven citizens’ associations remained of which ten answered the questions, thus I got a sample of 10 RES-E in wind power owned by citizen participation schemes.

In regard to solar power, the professional project developer mentioned above was involved in eight associations. In addition, two other professional developers were identified. One of them was responsible for the power plants of four associations. The other one developed eight associations, each in cooperation with a municipality. None of the professional project developers answered the

<sup>3</sup> The definition of the feed-in tariffs as subsidies is not undisputed. It is argued that these have rather to be considered as the internalization of external costs ([24], p. 683).

questions. In the latter case, I got information about five associations from the municipalities involved. The other thirteen citizens' associations identified were either developed by a municipality or by private individuals. Eleven of these associations provided me with the relevant information. Finally, 16 out of 33 associations operating solar power plants answered the questions, thus I got a sample of 16 RES-E in solar power owned by citizen participation schemes.

Since I was also interested in the sex ratio of leadership positions within the different associations, I got in contact again with those associations that already had answered the first questions. Due to the above-mentioned differences in the corporate form, the associations differ in regard to their managerial positions. Dependent on the managerial positions, I asked about the sex ratio in the executive or supervisory board. In a nutshell, data gathering was very time consuming since there is no data available on citizen participation schemes on the one hand, and I was dependent on the cooperativeness of the managerial level of the associations on the other.

### 3. Gender relations and citizen participation schemes in renewable electricity production: analytical approach

Over the past twenty years, extensive research has documented mutual interdependencies between gender relations and energy policy (for recent reviews, see [33,67,75]). To date, however, research on gender and energy evolved parallel but more or less unconnected to social science energy research. This is quite remarkable since both branches of research deal with similar questions about mutual interdependencies between individuals and energy policy and their dynamics within time, space and institutional context. Initially, attention was primarily paid to gender and energy in the context of developing countries [34]. At the beginning of the 2000s, research focused also on industrial countries [35].

Since both contexts are quite different in regard to supply as well as utilization of energy resources [75], gender and energy research deals with different issues according to the stage of economic development. In the context of developing countries, research is mainly focused on practical needs of women in order to enable them to fulfill their traditional reproductive tasks in less laborious and healthier ways [36,67]. Rather than access to modern energy and practical needs, women's entitlements to use energy services, as well as their participation in both energy policy-making and the energy sector, are issues of gender and energy research in the context of industrial countries [35,79]. These studies shed light on women's needs in terms of energy services. Against the background of their results, it was able to realign the focus from women to gender relations [20,67]. A better understanding of the socio-economic contexts and their impact on gender relations is claimed [37,38,33]. This new alignment not only complements the knowledge on gender and energy but is also the linking element between gender and energy in all stages of economic development.

Recently, Bendlin proposed a women's human rights perspective in order to inform and structure research on climate change mitigation about different impacts of mitigation on women and men [39]. This perspective is worthwhile but the challenge, in regard to gender and climate change as well as in regard to gender and energy, is to reveal gender-related differences since these are deeply embedded in institutions and norms and thus are accepted by individuals [40,41]. Cecelski [20] defined criteria for gender-sensitive energy research that fulfill the claim of analyzing gender and energy from a broader perspective and that are relevant in all contexts ([20], p. 66–7):

- Treating gender as a separate category of analysis, not as a subset of poverty.
- Gender analysis goes beyond women's practical welfare needs and addresses the transformation of gender relations.
- Women are not treated as a homogenous category.
- A bargaining model of the household is assumed, rather than a unitary model with identical interests.
- Gender relations as well as gender roles are analyzed (also beyond the household level).

In 2004, Cecelski already claimed to go beyond a materialist development perspective in energy research and to employ a perspective that is focused on power relations within society.

In the same vein, Kaijser and Kronsell [42] propose applying intersectionality as an analytical framework for revealing complex relationships between gender and climate change policy but which also might be useful in terms of gender and energy:

"Intersections of power structure political, economic, and social institutions on all levels. It is therefore necessary, in an intersectional analysis, not only to look for the adverse impacts of climate change on 'vulnerable' groups, but also to shed light on and expound the problems of norms and underlying assumptions that are naturalized and regarded as common sense, but build on and reinforce social categorisations and structures of power, not at least through institutional practices." ([42], p. 12).

Norms and institutions as forces shaping social categorization and structure of power within society are also emphasized by the concept of the gender regime. Its main idea is that gender relations are shaped by social institutions like markets, states, etc. by means of values and norms. The term gender regime refers to "the state of play in gender relations in a given institution" ([43], p. 120). Since they are socially constructed, gender regimes are dynamic.

A relevant question is how to grasp interdependencies between citizen participation schemes in RES-E and gender regimes. In order to solve this problem, recent social science's energy research is meanwhile suggesting that beyond the supply of and access to modern energy, it is also vital to consider the social distribution and inferred individual restraints of consuming energy services [15,44]. The most important vehicle for participating in citizen participation schemes in RES-E is a financial contribution by equity [87]. Thus, the key to civic participation in renewable electricity plants lies in personal assets. In capitalist societies, paid labor provides the major access to material resources. Thus, the social distribution of paid and unpaid labor is of special importance since it determines the access to material resources, authority, and social status. Gender inequality in employment becomes, among other things, evident in differences in women's and men's labor force participation, the gender wage gap, sex segregation of jobs and occupations as well as of managerial and supervisory positions in all capitalist countries though to varying degrees ([41], p. 5; [76]). In respect to citizen participation schemes in RES-E, the gender wealth gap, as well as sex segregation of managerial and supervisory positions, are reference points for analyzing women's agency and capabilities to participate in RES-E.

#### 3.1. Citizen participation schemes and the gender wealth gap

Different studies point out a gender wealth gap in capitalist societies [45,84]. An analysis of data provided by the German Socio-Economic Panel (SOEP) revealed a gender wealth gap of the total amount of 27,000 Euro in Germany in 2012. On average, men had a personal wealth to the amount of 97,000 Euro at their disposal, women in contrast 70,000 Euro. Thus, on average women accumulate only 72 per cent of the amount of wealth accumulated by men ([72], p. 160). Between 2002 and 2012 the gender wealth

gap decreases but only to a small extent. In 2002, the amount of the total gender wage gap was 29,000 Euro. The average personal wealth accumulated by women had been up to 70 per cent of that accumulated by men (67,000/96,000 Euro) ([70], p. 670–1).

**H<sub>1</sub>.** Against the background of the gender wealth gap, it is expected that on average the total investment volume provided by women is lower than the total investment volume provided by men.

**H<sub>2</sub>.** Since women accumulate only 72 percent of the amount of wealth accumulated by men on average, it is moreover expected that the total investment volume provided by women is about 72% of the total investment volume provided by men.

Renewable electricity production plants are quite different in terms of capital intensity. Due to the relatively high capital intensity of wind power plants these were mainly operated by citizens' corporations in the early days of renewable energy in Germany. The main idea was that the larger the group of participants, the lesser the share of capital that had to be brought in by each individual. In contrast, solar power plants were initially mainly operated by homeowners. As photovoltaic cells became technologically more developed, citizen participation schemes also evolved in solar energy. The purpose of this movement was to avoid a participation bias in favor of higher income groups in renewable energy since solar power plants compared to wind power plants are much less capital intensive [78]. Therefore, it is expected that the gender ratio in terms of both ownership rate as well as investment sum is balanced.

**H<sub>3</sub>.** Women's and men's ownership rates in citizens' associations operating solar power plants are balanced.

**H<sub>4</sub>.** In citizen participation schemes operating solar power plants, the ratio of the investment sums provided by women and men are balanced.

Despite the expectation of a gender-balanced ownership rate in solar power, the argumentation so far also suggests that women's ownership rate in citizen participation schemes in RES-E is in general lower than that of men.

**H<sub>5</sub>.** Women's ownership rate in citizen participation schemes in RES-E is lower than that of men.

### 3.2. Voting and control rights

Involvement in citizen participation schemes in RES-E by means of capital contribution and ownership provides not only interests in economic terms but also in participation in decision-making by voting and control rights. The corporate forms occurring in our sample (GmbH, GbR, eG) differ in regard to the distribution of voting and control rights. According to the Act on German Limited Liability Companies (GmbHG), the share of votes within a limited liability corporation (GmbH) depends on the nominal value of a share. The GmbH is the most common corporate form of wind power plants [78]. Against the background of the expectation that women's share of total investment is lower than that of men, it is also expected that women have lower voting rights at their disposal compared to men.

**H<sub>6</sub>.** In GmbHs, women's investment share is lower than that of men.

The distribution of votes within civil law associations (GbR) and cooperatives (eG) is also regulated by law. In both cases, each shareholder (GbR) or each member (eG) has one vote at his or her disposal. Therefore, in these cases the gender ratio of the ownership rate is critical for women's participation in decision-making.

**H<sub>7</sub>.** In GbRs, women's ownership rate is lower than that of men.

**H<sub>8</sub>.** In eGs, women's ownership rate is lower than that of men.

Both, cooperatives and civil law associations are quite democratic in regard to decision-making processes. But they differ in regard to liability to partners. Whereas shareholders of civil law associations are liable with the whole of their property, the liability of cooperation shareholders is limited to cooperative property ([47], p. 135; [19], p. 61). Against the background of findings of women being more risk-averse than men [48], it is ascertained that women's participation rates are higher in cooperatives than in civil law associations.

**H<sub>9</sub>.** Women's ownership rate is higher in eGs than in GbRs.

### 3.3. Women's representation in boards and management groups

From a gender perspective, beyond making a financial contribution another central aspect of citizen participation in renewable electricity production is taking over management tasks. In general, citizens' associations differ in regard to the decision-making structure due to their different corporate forms. Wind power plants are commonly organized as limited liability corporations (GmbH or GmbH & Co. KG). In principle, the executive board is equipped with decision-making power whereas the other shareholders have rights of information and control at their disposal. In contrast, the decision-making power of a civil law association (GbR) is equally distributed. However, usually an executive board is authorized to take over the management.

The most common corporate forms of solar power plants are GbR and cooperative (eG). The specifics of the former are explained above. Generally, an eG consists of three organs: general meeting, supervisory board and executive board. The general meeting elects the supervisory board that designates and controls the executive board. Similarly to the GbR, the eG is said to be quite democratic in character since decision-making power is equally distributed within the general meeting. Important decisions like articles of corporation have to be made by the general meeting.

In Germany, women are underrepresented in both the electricity industry as well as in managerial positions. The former circumstance is traced back to gender-specific occupational segregation [77]. Thus, women are also underrepresented in energy company boards and management groups: "In Germany, one reason cited for not having women on the board was the small board size (5 members), meaning that if they had one woman on the board the proportion of women would be 20%, which is much more than the 2% average in Germany. Another reason for having no women on the board in Germany was that the company culture there is very male-oriented, making it difficult for women to reach higher positions [...] ( [49], p. 4739). These results are confirmed for renewable energy where women are underrepresented in companies as well as associations [85].

**H<sub>10</sub>.** Women are underrepresented in managerial positions in citizens' associations operating renewable electricity production plants.

### 3.4. Preferences for energy sources

Since 2009 the Ministry for the Environment, Nature Conservation and Nuclear Safety and the Federal Agency for Nature Conservation has conducted a German population survey every two years. Each of these surveys is based on a representative sample of about 2000 persons of the German-speaking resident population from the age of 18 years taking into consideration all socio-demographic segments and integrating people of all regions

in Germany. The most recent surveys of 2011 and 2013 both show that the preferences of women and men regarding the energy transformation are not so different, both sexes mainly advocate it. But both surveys clearly indicate that age, education and income matter regarding the support of the German Energy Transformation [64,65].

These findings about the importance of education and income as factors influencing the support of renewable energy give rise to the assumption that participation in renewable energy production is not just a matter of gender but also a matter of social categorisations and social structures of power, as is also explained by recent research on climate change [42]. In the context of the gender wealth gap, these findings suggest that women have to be provided with above-average personal assets in order to engage in renewable electricity production. But if they overcome this hurdle, their engagement in renewable electricity production does not differ compared to men, i.e. the provided investment per capita is on average equivalent. This suggestion is supported by recent research on the gender wage gap in Germany showing that the gap becomes smaller against the background of rising monthly income [68].

**H<sub>11</sub>.** If women participate in renewable electricity production, their financial contribution by equity per capita is similar to those of men.

#### 4. Results

In this section, the results of the pilot study are presented. It has to be reminded that the aim of this pilot study is to explore causal mechanisms between gender regimes internalized in social, cultural and political contexts and the unequal gender ratios in citizen participation schemes in RES-E. The aim is not to prove these mechanisms statistically on the basis of comprehensive data.

##### 4.1. Participation in citizen associations in RES-E by gender

Against the background of the gender wealth gap it was expected in hypothesis one (H<sub>1</sub>) that on average the total investment volume provided by women is lower than that of men per citizen participation scheme in RES-E. Boxplot one shows that on average 106,259.80 Euro per RES-E scheme is mobilized by women and 467,659.60 Euro by men. This difference is significant with a *p*-value of 0.03. H<sub>1</sub> is therefore confirmed by the pilot study's data. Beyond the general comparison of women's and men's investment sum, in light of research results indicating a gender wealth gap of about 70 percent, this ratio was also quantified in hypothesis two (H<sub>2</sub>). The results show that compared to the mean investment provided by men, 23 percent is provided by women. Moreover, compared to the mean of total investment, the women's share of total investment is 20 percent. H<sub>2</sub> cannot be confirmed but has to be corrected since on average the proportion of women's investment sum measured by men's is even lower than the proportion of women's average wealth measured by men's average wealth (Boxplot 1).

As described in hypotheses three (H<sub>3</sub>) and four (H<sub>4</sub>), a balanced gender ratio is expected if data on citizen participation schemes operating solar power plants is considered exclusively. The pilot study's data reveals that H<sub>3</sub>, suggesting that the ownership rate is gender balanced, has to be rejected. The mean of female ownership rate is 0.23, those of men is 0.7. The *t*-test confirms that this difference is statistically highly significant with a *p*-value about 0. Interestingly, the ratio of the mean investment of women and men seems to be balanced as claimed in H<sub>4</sub>. On average, 48,871.25 Euro is mobilized by women and 113,095.94 Euro by men. According to the *t*-test this difference is not significant with a *p*-value of

0.08. On the other hand, the power *t*-test reveals a power of test level of 0.48. Thus, H<sub>4</sub> can neither be confirmed nor rejected reliably. These results indicate that relative small capital contributions do not attract women's ownership but rather equalize women's and men's nominal value of investment on average. This finding is interesting against the background of the distribution of voting and control rights since these are allocated according to the principle of 'one person, one vote' within GbRs and eGs being the most common corporate forms of citizen participation schemes operating solar power plants. Therefore, an equalized nominal value of investment on average might only have a positive effect on gender equality in economic terms and not in participation in decision-making (Boxplot 2).

In hypothesis five (H<sub>5</sub>) it is suggested that women's ownership rate in citizen association schemes in RES-E is in general lower than those of men. Against the background of the rejection of H<sub>3</sub> this suggestion becomes more reasonable because women's involvement in citizen participation schemes in RES-E seems to be lower than those of men in general. On average, 22 per cent of the owners per RES-E are women and 75 per cent are men. Others are communities or firms. According to the *t*-test this difference is highly significant with a *p*-value about 0. Thus, women's generally low involvement appears to be dependent on other than technical factors like energy source or financial factors like capital-intensity of investment.

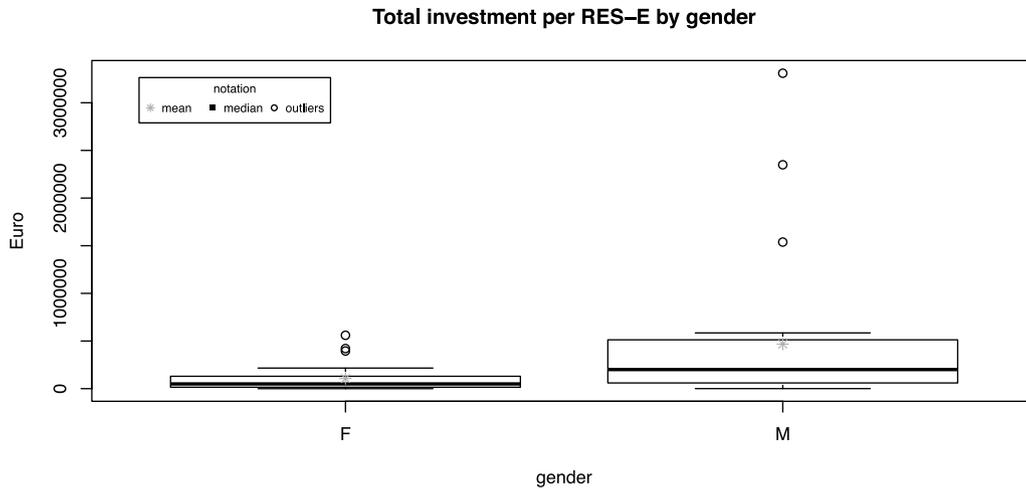
##### 4.2. Participation in decision-making

Beyond participation in terms of ownership and investment share, participation in decision-making is also an integral component of citizen participation schemes in RES-E. As explored above, within a GmbH voting and control rights are allocated according to shareholders' nominal value of share. In hypothesis six (H<sub>6</sub>) it is suggested that women's investment share is lower than those of men in GmbHs. Within the citizen participation schemes organized as GmbHs, women provided on average 205,646.20 Euro per GmbH, men 1,117,179.40 Euro. This gender difference of the mean investment per GmbH is significant with a *p*-value of 0.03. On average, women provide 31 percent of total investment per GmbH. Since H<sub>6</sub> is confirmed, it can be inferred that women have less voting and control rights at their disposal than men within GmbHs.

The distribution of votes within GbR and eG is effected by means of the principle 'one person, one vote'. In hypotheses seven (H<sub>7</sub>) and eight (H<sub>8</sub>) it was argued that women's ownership rates are lower than men's in both GbRs as well as in eGs. On average, 20 percent of the owners per GbR are women, 73 percent are men. According to the *t*-test this difference is highly significant (*p*-value about 0). On average 31 percent of the owners per eG are women, 67 percent are men. This difference is also highly significant (*p*-value about 0). Others are communities or firms, in both cases. Again, since both H<sub>7</sub> and H<sub>8</sub> are confirmed, the conclusion has to be drawn that women have less voting and control rights at their disposal than men.

Although GbRs and eGs have many characteristics in common, they differ in a crucial point: liability. In contrast to the GbR, the liability of eG owners is limited to cooperative property. Since participation in a GbR seems to be more risky than participation in an eG against this background, it is maintained in hypothesis nine (H<sub>9</sub>) that women's ownership rate is higher in eGs than in GbRs. On average, women's ownership rate is 20 per cent per GbR and 31 per cent per eG. This difference is proven to be statistically significant by means of a pairwise *t*-test (*p*-value = 0.05).<sup>4</sup>

<sup>4</sup> The results of the pairwise *t*-test show moreover that the difference of women's ownership rate between eG and GmbH is also significant (*p*-value = 0.02) but those between GbR and GmbH is not (*p*-value = 0.44).



B. lot 1}} Total investment sum per RES-E by gender.

Source: Own calculation, see Appendix.

#### 4.3. Leadership in renewable energy citizens' associations

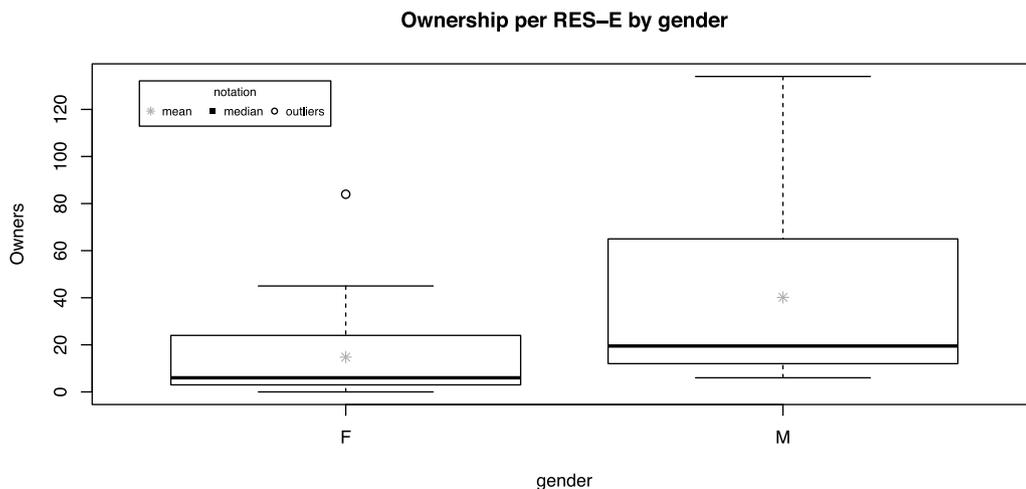
From a gender perspective, questions about leadership in citizens' associations operating renewable electricity production are also of special interest. In hypothesis ten ( $H_{10}$ ) the underrepresentation of women in leadership positions in citizen participation schemes is suggested. It is explained by the gender-specific occupational segregation that causes among other factors the marginalization of women in both the electricity industry as well as in managerial positions in general. On average, 2.42 men and 0.25 women are in leadership positions per citizen participation scheme in RES-E. This difference is significant with a  $p$ -value about 0. Thus  $H_{10}$  is confirmed.

#### 4.4. Gender ratio in per capita investment

Recent studies on individual preferences on energy transformation reveal that age, education and income are crucial factors in contrast to gender [64,65]. Therefore, the unequal gender ratio in involvement in citizen participation schemes in RES-E cannot

be traced back to differences in individual preferences but to differences in social categorisations and social structures of power. Against the background of gender-related structures of power like the gender wealth gap or the gender wage gap it is postulated that women have to be relatively affluent in order to engage in renewable electricity production. In consequence, it is suggested that the financial interest held by women per capita ( $pc$ ) does not differ from those of men ( $H_{11}$ ).

The mean of female investment per capita is 12,092.69 Euro, those of men is 19,310.58 Euro. According to the  $t$ -test, this difference is not significant ( $p$ -value 0.42). But the power  $t$ -test reveals a power of test level of 0.5. Thus  $H_{11}$  can neither be confirmed nor rejected on the basis of the pilot study's data. Nevertheless, this inconclusive result is interesting against the background of the above-presented statistically significant results on unequal gender ratios in ownership rate and investment sum. More research is needed in order to explore if a participation bias in favor of higher income groups exist. Such a bias might not to be an obstacle for participation of women per se, but it might be detrimental to female participation in general.



B. lot 2}} Ownership per RES-E by gender.

Source: Own calculation, see Appendix.

## 5. Discussion

Based on both citizen participation in RES-E literature as well as research on gender and energy, the paper examined whether a gender difference in the involvement in citizens' participation schemes in RES-E exists. In order to explore differences, eleven hypotheses from research on gender differences caused by institutional and cultural conditions were derived and tested by conducting a pilot study. First of all, the results reveal statistically significant gender differences in the average ownership rate in citizen participation schemes, the average investment sum and leadership positions. In contrast, the findings on gender differences in the amount of capital assets invested per capita are inconclusive. Thus, this pilot study does not provide evidence on the existence or non-existence of gender-related differences in individual preferences for involvement in citizen participation schemes in RES-E. But the results give an indication of the existence of cultural, social and political factors affecting gender differences in participation in RES-E operated by citizens' associations.

### 5.1. Tax legislation

The gender wealth gap in Germany is about 30%, i.e. compared to men's wealth, women accumulate 70% ([72], p. 160). Since a financial contribution by equity is the key to joining a citizen participation scheme in RES-E, the differences in total financial interest acquired by women and men are explained by this gap. But results also show that the gender gap in capital investment is even larger than the gender wealth gap – compared to men's mean investment, 23 percent is provided by women. Therefore, on average the gap between the mean investment of women and men measured as a proportion of women's investment sum compared to men's is even greater than the gender wealth gap.

One might argue that this gender ratio in participation is biased because it might be that shares are formally held by men but informally by spouses. Thus, regarding civic participation in renewable energy, questions about wealth distribution between spouses have to be raised. A lot of research has been done about it in recent years. From a methodological point of view, this research is quite challenging, especially in regard to data-gathering. In most of the datasets providing data about wealth distribution the household is the elementary unit because it is assumed that income and wealth are equally distributed at the household level. But several studies refute this assumption [50,51,71,74,80]. Therefore, an explanation for the gap between the gender ratio of investment volume in citizen associations and the gender wealth gap might be the distribution of assets within couples.

On the basis of the SOEP data, a gender wealth gap between spouses to the average amount of 46,000 Euro is revealed. On average married women accumulated only 64 per cent of the amount of wealth accumulated by married men. Thus, the gender wealth gap is even larger within couples than in general ([46]; [84], p. 680). The larger gender wealth gap within couples is on the one hand explained by the commensurable trend that on average women marry relatively older and relatively higher educated men. In consequence, on average men possess more wealth at the time of marriage ([84], p. 670–1). But for the most part, this distribution is influenced by income taxation. In Germany, married couples are taxed jointly by the so called income splitting. That means that the spouses' incomes are added up. Half of this sum is assigned to each spouse for tax purposes. In consequence, no incentive is provided to transfer assets to the spouse with lower income since the actual allocation of assets between spouses does not matter for income taxation.

Studies from Great Britain show that a reform of the income tax system from joint to independent taxation provide an incentive to transfer assets to the spouse with the lower marginal tax rate in order to reduce the household's tax burden: "We estimate that a 10 percentage point differential in spouses' marginal tax rates leads to a 2.6–3.1 percentage point increase in the share of investment income allocated to the spouse with the lower marginal tax rate." ([52], p. 1990) More recent studies confirm these findings for Great Britain [74] and Canada [53]. Actual fiscal law provides no incentive to transfer shares of renewable energy plants to the spouse with lower income.

Of course, these studies only refer to the *de jure* and not to the *de facto* distribution of wealth within couples ([46], p. 72). But the *de jure* distribution of shares between couples is of special importance since decision and control rights are dependent on the *de jure* ownership, the *de facto* one is formally irrelevant. In this regard it is quite interesting that some of the interviewed persons mentioned that shares formally held by men but informally held by spouses in order to argue that the mere figures are biased. On the other hand, only two out of 26 citizen participation schemes report couples as shareowners within our sample. In general, citizen participation associations in RES-E are reluctant to allow for couples as shareowners due to formally undefined distribution of vote and control rights.

### 5.2. Occupational segregation

Moreover, the results show that women participate far less than men in the decision-making bodies of citizen-owned RES-E. This is quite interesting since executive activities consist mainly of business tasks. Evidence from research on women's entrepreneurship reveals that there are differences in access to capital, networking behavior and business performance ([54], p. 325). Overall, the rate of female employees is rather small although the biggest share of occupations within the renewable energy branch is also administrative. It is argued that this is the reason why the low female participation rate within this branch cannot be explained by its supposed above-average technical orientation ([63], p. 111–3). Of course, there are many reasons for these gender differences that are complex as well. A great deal of these reasons is rooted in individual motivation, i.e. self-perception, self-consciousness, etc. But reasons are also rooted in structural gaps. The gender segregation of the labor market seems to be of special importance. There are many initiatives in Germany to break this segregation up, the so-called MINT initiatives that aim to draw girls' and women's interest in mathematics, informatics, sciences, and engineering. But employees' interest, perceptions, attitudes, etc. are only one side of the coin, employers' expectations, experiences, etc. are the other. Overall, both sides are influenced by structural factors like socio-economic or cultural ones ([55], p. 574; [56]).

Moreover, executive boards in citizens' associations are mainly run by unpaid volunteers. Therefore, this new kind of business is similar to the German sports system where women are also underrepresented in executive bodies [57]. Reasons for this underrepresentation are manifold [58]. "As the results of the "Women taking the lead" has shown, one precondition of becoming a leader in a German sports organization is a long and continued commitment to sport and sports organizations." ([57], p. 113) Thus, a precondition of taking part in executive boards in renewable electricity production might be either experience in business or experience in technology. Furthermore, the research about the women in sport organizations also indicates the importance of female role models ([59], p. 209).

Moreover, contextual factors like the gender wealth gap or occupational segregation also influence women's and men's investment

behavior. The study shows that women are more likely to participate in eG than in GbR. As presented, these corporate forms differ particularly in terms of liability. The hypothesis was derived from literature explaining gender differences in investment behavior by individual attitude. But this explanation alone falls short: “Financial risk tolerance is no doubt related to how financially vulnerable one would feel if the investment were to fail. [...] It is very difficult to separate gender differences in financial risk tolerance from the broader conditions that women and men face in society, such as the glass ceiling at work, the gender wage gap, and gender norms that place financial matters in the realm of male expertise.” ([45], p. 94) Therefore, it seems that the corporate form eG better fits women’s agency to involve in RES-E.

### 5.3. Gender gap in RES-E: contextual factors

Thus far, the discussion has shown that the gendered social distribution of both paid and unpaid labor shape women’s and men’s agency and capabilities to participate in RES-E differently. Two structural outcomes of this gendered distribution of labor are of special importance in terms of citizen participation schemes in RES-E: the gender wealth gap and gendered occupational segregation. Thus, the question about the sources of the social distribution of labor remains. Within the discussion they were traced back to social institutions like tax law. Cooke [21] argued that the distribution of paid and unpaid work, and thus relative gender, class and other group inequality, is mainly structured by governmental policies: education policies, labor regulations, social insurance programs, public and private transfers, and tax and family law ([21], p. 14). Thus, citizen participation schemes in RES-E do not emerge independent of the institutional context but reflect it in terms of their social outcomes. The assumption of the egalitarian democratic ideal has to be replaced by a more realistic one based on the “institutional equality frame that structured relative gender, class, and other group equality in paid and unpaid work” ([21], p. 3).

Some scholars propose to institutionalize so called ‘earner-carer’ policies that strengthen both employment incentives for women and care incentives for men [76]. Other scholars challenge the view that an institutional approach alone will be able to implement greater gender equality in terms of employment as well as the distribution of paid and unpaid employment. Charles and Bradley [60] put an emphasis on the influence of the cultural force of the gender ideology: “The segregative effect of gender-essentialist beliefs is intensified [...] by a strong Western cultural emphasis on individual self-expression and self-realization that has been diffusing worldwide since World War II [...] Because gender remains so central an axis of human identity, we argue that self-expressive value systems tend to encourage the development and enactment of culturally masculine or feminine affinities.” ([60], p. 925–6) In this paper, women’s low participation in leadership positions in citizen participation schemes was also traced back to cultural factors.

Against the background that the gender investment gap in citizen participation schemes in RES-E is even higher than the gender wealth gap, it seems that both institutional and cultural factors not only reinforce but also strengthen gender inequalities because they accelerate each other. It is this interdependency of institutional and cultural factors that make gender relations a specific matter within energy transformations. But both institutional and cultural forces are not necessarily detrimental to gender equality. Charles and Bradley [60] for instance point out that “economic modernization does not have the degendering effect that modernization scholars expect because realization of any preference for lower-paid female-typed careers is more constrained (and less culturally legitimate) under conditions of greater scarcity.” ([60],

p. 659) Thus, this paper identified the causal mechanism between institutional and cultural context and social outcomes in regard to citizen participation schemes in RES-E. Whether these factors are detrimental or favorable to gender equality, in terms of citizen participation schemes in RES-E, is context dependent. Further research on women’s and men’s participation in other contexts is needed in order to provide additional and more concrete knowledge about the scope and nature of the identified causal mechanism.

## 6. Conclusion

Against the background of both claims to intensify interdisciplinary research on energy policy [61] as well as to pay more attention to the micro-scale socio-economics of energy technologies [15], this paper argues that research on citizen participation schemes in RES-E needs to integrate the broader social, cultural and political contexts, since these shape individuals’ agency and capabilities to participate. To date, the focus of the literature on citizen participation schemes in RES-E has been solely on the investors and their investment decision. In order to estimate both social outcomes as well as social conditions of citizen participation schemes in RES-E the paper goes beyond this focus and explores why men are more likely to engage in these schemes. As result, it identified a causal mechanism between institutional and cultural context and gendered social outcomes in terms of citizen participation. Since this causal mechanism is context-dependent the actual results of a gender gap in participation are only valid in the German context. Further research is needed in order to reveal the gender ratio in citizen participation schemes in RES-E in other contexts.

In general, the paper revealed that approaches to citizen participation schemes in RES-E focusing only on technical and economic aspects fall short. A social science perspective is also needed in order to complement research with knowledge on both social conditions as well as social outcomes of these schemes. Moreover, the results show that citizen participation schemes in RES-E do not fulfill the claim of egalitarian democratic ideal per se. In the German case, it reveals that some kind of ‘countervailing’ power is needed in order to avoid a social imbalance in terms of the social distribution of benefits and costs of RES-E. A solution might be to gain more knowledge about the influence of different stakeholder groups [62] and to create policies in order to strengthen those stakeholders whose agency and capabilities in terms of ‘regular’ participation are constrained.

## Acknowledgements

I gratefully acknowledge financial support from the North Rhine-Westphalian Ministry for Innovation, Science and Research (funding program gender research) as well as both the Research Center “Shaping the future” (FoKoS) and the Rectorate of the University of Siegen for the research project “Gendered Effects of the German Energy Transformation in Südwestfalen” (GAES). I would like to thank Jacqueline Klesse for both reviewing the German legal framework of citizen participation schemes in RES-E as well as for her support in data gathering and Kate Backhaus for language-editing. Moreover, I would like to thank Prof. Benjamin K. Sovacool and the reviewers as well as the participants of the section “Gender and Politics” of the Midwest Political Science Association’s 2014 conference for valuable comments on my manuscript.

## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.eress.2015.02.005.

## References

- [1] Helm D. The new energy paradigm. In: Helm D, editor. *The new energy paradigm*. Oxford: Oxford University Press; 2007. p. 9–35.
- [2] Masini A, Menichetti E. Investment decisions in the renewable energy sector: an analysis of non-financial drivers. *Technol Forecast Soc* 2013;80(3):510–24.
- [3] Oteman M, Wiering M, Helderma J-K. The institutional space of community initiatives for renewable energy: a comparative case study of the Netherlands, Germany and Denmark. *Energy Sustain Soc* 2014;4(1):11.
- [4] Bergek A, Mignon I, Sundberg G. Who invests in renewable electricity production? Empirical evidence and suggestions for further research. *Energy Policy* 2013;56:568–81.
- [5] Wüstenhagen R, Menichetti E. Strategic choices for renewable energy investment: conceptual framework and opportunities for further research. *Energy Policy* 2012;40:1–10.
- [6] Breukers S, Wolsink M. Wind power implementation in changing institutional landscapes: an international comparison. *Energy Policy* 2007;35(5):2737–50.
- [7] Wolsink M. Wind power: basic challenge concerning social acceptance. In: Kaltschmitt M, Themelis NJ, Bronicki LY, Söder L, Vega LA, editors. *Renewable energy systems*. New York, NY: Springer; 2013. p. 1785–821.
- [8] Wüstenhagen R, Wolsink M, Bürer MJ. Social acceptance of renewable energy innovation: an introduction to the concept. *Energy Policy* 2007;35:2683–91.
- [9] Enzensberger N, Fichtner W, Rentz O. Evolution of local citizen participation schemes in the German wind market. *Int J Glob Energy Issues* 2003;20(2):191–207.
- [10] Mautz R, Rosenbaum W. Der deutsche Stromsektor im Spannungsfeld energiewirtschaftlicher Umbaumodelle. *WSI Mitteilungen* 2012;65(2):85–93.
- [11] Minsch J, Goldblatt DL, Flüeler T, Spreng D. The indispensable role of social science in energy research. In: Spreng DT, Flüeler T, Goldblatt DL, Minsch J, editors. *Tackling long-term global energy problems. The contribution of social science*. New York: Springer; 2012. p. 23–43.
- [12] White LA. Energy and the evolution of culture. *Am Anthropol* 1943;45(3):335–56. <http://www.jstor.org/stable/663173>
- [13] Nye DE. *Consuming power. A social history of American energies*. Cambridge, MA: MIT Press; 1998.
- [14] Ossing F, Polster W, Thomasberger C, Voy K. Innere Widersprüche und äußere Grenzen der Lebensweise – Aspekte der ökologischen Entwicklung. In: Voy K, Polster W, Thomasberger C, editors. *Gesellschaftliche Transformationsprozesse und materielle Lebensweise. Beiträge zur Wirtschafts- und Gesellschaftsgeschichte der Bundesrepublik Deutschland (1949–1989)*. Marburg: Metropolis; 1991. p. 321–79.
- [15] Miller CA, Richter J, O'Leary J. Socio-energy systems design: a policy framework for energy transitions. *Energy Res Soc Sci* 2015;6:29–40. <http://www.sciencedirect.com/science/article/pii/S2214629614001236>
- [16] Aitken M. Why we still don't understand the social aspects of wind power: a critique of key assumptions within the literature. *Energy Policy* 2010;38(4):1834–41.
- [17] van Ingen E, van der Meer T. Welfare state expenditure and inequalities in voluntary association participation. *J Eur Soc Policy* 2011;21(4):302–22.
- [18] Radtke J. Bürgerenergie in Deutschland – ein Modell für Partizipation? In: Radtke J, Henning B, editors. *Die deutsche "Energiewende" nach Fukushima. Der wissenschaftliche Diskurs zwischen Atomausstieg und Wachstumsdebatte*. 1st ed. Weimar (Lahn): Metropolis; 2013. p. 139–82.
- [19] Yıldız Ö, Rommel J, Debor S, Holstenkamp L, Mey F, Müller JR, et al. Renewable energy cooperatives as gatekeepers or facilitators? Recent developments in Germany and a multidisciplinary research agenda. *Energy Res Soc Sci* 2015;6:59–73.
- [20] Cecelski E. ENERGIA/EASE Discussion Paper Re-thinking gender and energy: old and new directions; 2004. [http://www.energia.org/fileadmin/files/media/pubs/cecelski2004\\_rethinking\\_ge.pdf](http://www.energia.org/fileadmin/files/media/pubs/cecelski2004_rethinking_ge.pdf) [accessed 19.12.14].
- [21] Cooke LP. *Gender-class equality in political economies*. New York, NY: Routledge; 2011.
- [22] International Energy Agency. *World energy outlook*. Paris Cedex: International Energy Agency; 2014.
- [23] Nolden C. Governing community energy—feed-in tariffs and the development of community wind energy schemes in the United Kingdom and Germany. *Energy Policy* 2013;63:543–52.
- [24] Toke D, Lauber V. Anglo-Saxon and German approaches to neoliberalism and environmental policy: the case of financing renewable energy. *Geoforum* 2007;38(4):677–87.
- [25] Gerring J. What is a case study and what is it good for? *Am Polit Sci Rev* 2004;98(02).
- [26] Sovacool BK, Kryman M, Smith T. Scaling and commercializing mobile biogas systems in Kenya: a qualitative pilot study. *Renew Energy* 2015;76:115–25.
- [27] Mobarak AM, Dwivedi P, Bailis R, Hildemann L, Miller G. Low demand for nontraditional cookstove technologies. *Proc Natl Acad Sci U S A* 2012;109(27):10815–20.
- [28] Rasch B, Friese M, Hofmann WJ, Naumann E. *Quantitative methoden 1. Einführung in die Statistik für Psychologen und Sozialwissenschaftler*. 4th ed. Berlin, Heidelberg: Springer; 2014.
- [29] Global Wind Energy Council. *Global wind statistics 2013; 2014*, February. [http://www.gwec.net/wp-content/uploads/2014/02/GWEC-PRstats-2013\\_EN.pdf](http://www.gwec.net/wp-content/uploads/2014/02/GWEC-PRstats-2013_EN.pdf) [accessed 06.01.14].
- [30] trend:research. *Marktakteure Erneuerbare - Energien - Anlagen in der Stromerzeugung*. Köln; 2011. <http://www.kni.de/pages/posts/neue-strome-erzeugungldquo-32.php> [accessed 06.01.14].
- [31] Kießling A. Politische Unternehmenskommunikation und angewandte Politikforschung – Potentiale und Limitationen am Beispiel der Erneuerbaren Energien-Politik im Wandeljahr 2011. In: Glaab M, Korte K-R, editors. *Angewandte Politikforschung*. Wiesbaden: VS Verlag für Sozialwissenschaften; Imprint: VS Verlag für Sozialwissenschaften; 2012. p. 211–22.
- [32] Jacobsson S, Lauber V. The politics and policy of energy system transformation—explaining the German diffusion of renewable energy technology. *Energy Policy* 2006;34(3):256–76.
- [33] Ryan SE. Rethinking gender and identity in energy studies. *Energy Res Soc Sci* 2014;1:96–105.
- [34] Parikh JK. Gender issues in energy policy. *Energy Policy* 1995;23(9):745–54.
- [35] Clancy J, Röhr U. Gender and energy: is there a Northern perspective? *Energy Sustain Dev* 2003;7(3):44–9.
- [36] Ding W, Wang L, Chen B, Xu L, Li H. Impacts of renewable energy on gender in rural communities of north-west China. *Renew Energy* 2014;69:180–9.
- [37] Danielsen K. *Gender equality, women's rights and access to energy services. An inspiration paper in the run-up to Rio+20*. Copenhagen: Ministry of Foreign Affairs of Denmark; 2012. [http://www.kit.nl/gender/wp-content/uploads/publications/1975\\_Gender%20Rights%20and%20Energy%20Report%20final.pdf](http://www.kit.nl/gender/wp-content/uploads/publications/1975_Gender%20Rights%20and%20Energy%20Report%20final.pdf)
- [38] Pachauri S, Rao N. Gender impacts and determinants of energy poverty: are we asking the right questions? *Curr Opin Environ Sustain* 2013;5(2):205–15.
- [39] Bendlin L. Women's human rights in a changing climate: highlighting the distributive effects of climate policies. *Camb Rev Int Aff* 2014;27(4):680–98.
- [40] Magnusdottir GL, Kronsell A. The (In)visibility of gender in Scandinavian climate policy-making. *Int Fem J Polit* 2014;1–19.
- [41] Ridgeway CL. *Framed by gender. How gender inequality persists in the modern world*. New York: Oxford University Press; 2011.
- [42] Kaijser A, Kronsell A. Climate change through the lens of intersectionality. *Environ Polit* 2013;23(3):1–17.
- [43] Connell R. *Gender and power. Society, the person and sexual politics*. Cambridge, UK: Polity Press in association with B. Blackwell; 1987.
- [44] Steinberger JK, Roberts JT. From constraint to sufficiency: the decoupling of energy and carbon from human needs, 1975–2005. *Ecol Econ* 2010;70(2):425–33.
- [45] Chang ML. *Shortchanged. Why women have less wealth and what can be done about it*. New York: Oxford University Press; 2012.
- [46] Frick JR, Grabka MM, Hauser R. *Die Verteilung der Vermögen in Deutschland. Empirische Analysen für Personen und Haushalte*. Berlin: Sigma; 2010.
- [47] Wien A. *Handels- und Gesellschaftsrecht*. Wiesbaden: Springer Fachmedien; 2013.
- [48] Graham JF, Stendardi EJ, Myers JK, Graham MJ. Gender differences in investment strategies: an information processing perspective. *Int J Bank Mark* 2002;20(1):17–26.
- [49] Carlsson-Kanyama A, Juliá IR, Röhr U. Unequal representation of women and men in energy company boards and management groups: are there implications for mitigation? *Energy Policy* 2010;38(8):4737–40.
- [50] Bennett F, Sung S. Dimensions of financial autonomy in low-/moderate-income couples from a gender perspective and implications for welfare reform. *J Soc Policy* 2013;42(04):701–19.
- [51] Ludwig-Mayerhofer W. *Geldverwaltung und -verteilung in paarbeziehungen*. Z für Sozial 2006;52(4):467–91.
- [52] Stephens Jr M, Ward-Batts J. The impact of separate taxation on the intra-household allocation of assets: evidence from the UK. *J Public Econ* 2004;88:1989–2007.
- [53] Alan S, Atalay K, Crossley TF, Jeon S-H. New evidence on taxes and portfolio choice. *J Public Econ* 2010;94(11–12):813–23.
- [54] de Bruin A, Brush CG, Welter F. Advancing a framework for coherent research on women's entrepreneurship. *Entrep Theory Pract* 2007;31(3):323–39.
- [55] Caraway TL. Comparative political economy, gender, and labor markets. *Polit Gend* 2009;5(04):568–75.
- [56] Martin S. Gender, technology and work: understanding patterns in women's employment in science and technology occupations. In: *Proceedings of the 1999 international symposium on technology and society – women and technology: historical, societal, and professional perspectives*. 1999. <http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=00787319> [18.06.14].
- [57] Pfister G, Radtke S. Dropping out: why male and female leaders in German sports federations break off their careers. *Sport Manage Rev* 2006;9(2):111–39.
- [58] Wicker P, Breuer C, Hanau T. Gender effects on organizational problems—evidence from non-profit sports clubs in Germany. *Sex Roles* 2012;66(1–2):105–16.
- [59] Skirstad B. Gender policy and organizational change: a contextual approach. *Sport Manage Rev* 2009;12(4):202–16.
- [60] Charles M, Bradley K. Indulging our gendered selves? Sex segregation by field of study in 44 Countries1. *Am J Sociol* 2009;114(4):924–76.
- [61] Sovacool BK. What are we doing here? Analyzing fifteen years of energy scholarship and proposing a social science research agenda. *Energy Res Soc Sci* 2014;1:1–29.
- [62] Ruggiero S, Onkila T, Kuittinen V. Realizing the social acceptance of community renewable energy: a process-outcome analysis of stakeholder influence. *Energy Res Soc Sci* 2014;4:53–63.

- [63] Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU). Erneuerbare Energien: Arbeitsplatzeffekte. Wirkungen des Ausbaus der erneuerbaren Energien auf den deutschen Arbeitsmarkt; 2006. [http://www.dlr.de/Portaldata/1/Resources/portal\\_news/NewsArchiv2006/EE\\_Arbeitsplatzeffekte\\_lang\\_web.pdf](http://www.dlr.de/Portaldata/1/Resources/portal_news/NewsArchiv2006/EE_Arbeitsplatzeffekte_lang_web.pdf) [13.06.14].
- [64] BMU. Naturbewusstsein 2011. Bevölkerungsumfrage zu Natur und biologischer Vielfalt; 2012. [http://www.bfn.de/fileadmin/MDb/documents/themen/gesellschaft/Naturbewusstsein.2011/Naturbewusstsein-2011\\_barrierefrei.pdf](http://www.bfn.de/fileadmin/MDb/documents/themen/gesellschaft/Naturbewusstsein.2011/Naturbewusstsein-2011_barrierefrei.pdf) [13.06.14].
- [65] Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit (BMUB). Naturbewusstsein 2013. Bevölkerungsumfrage zu Natur und biologischer Vielfalt; 2014. <http://www.bfn.de/fileadmin/MDb/documents/themen/gesellschaft/Naturbewusstsein.2013.pdf> [13.06.14].
- [66] Chappin E.J.L., Ligtoet A. Transition and transformation: a bibliometric analysis of two scientific networks researching socio-technical change. *Renew Sustain Energy Rev* 2014;30:715–23.
- [67] Clancy J, Winther T, Matinga M, Oparaocha S. Gender equity in access to and benefits from modern energy and improved energy technologies; 2012. [http://www.norad.no/en/thematic-areas/energy/gender-in-energy/\\_attachment/385686?\\_ts=13356322c17](http://www.norad.no/en/thematic-areas/energy/gender-in-energy/_attachment/385686?_ts=13356322c17) [21.12.14].
- [68] Gallego Granados P, Geyer J. Brutto größer als Netto: Geschlechtsspezifische Lohnunterschiede unter Berücksichtigung von Steuern und Verteilung. *DIW Wochenber* 2013;80(28):3–15.
- [69] Goldthau A, Sovacool BK. The uniqueness of the energy security, justice, and governance problem. *Energy Policy* 2012;41:232–40.
- [70] Grabka MM, Frick JR. Geld- und Realvermögensverteilung in Deutschland. *DIW Wochenber* 2007;74(45):665–72.
- [71] Grabka MM, Marcus J, Sierminska E. Wealth distribution within couples and financial decision making. CEPS/INSTEAD Working Papers 2; 2013. <http://www.statistiques.public.lu/catalogue-publications/working-papers-CEPS/2013/02-2013.pdf> [accessed 12.03.14].
- [72] Grabka MM, Westermeier C. Anhaltend hohe Vermögensungleichheit in Deutschland. *DIW Wochenber* 2014;81(9):151–65.
- [73] Hirschl B. Erneuerbare Energien-Politik. Eine Multi-Level Policy-Analyse mit Fokus auf den deutschen Strommarkt. 1st ed Wiesbaden: VS, Verl. für Sozialwiss; 2008.
- [74] Kan MY, Laurie H. Changing patterns in the allocation of savings, investments and debts within couple relationships. *Sociol Rev* 2014;62(2):335–58.
- [75] Köhlin G, Sill EO, Pattanayak SK, Wilfong C. Energy, gender and development. What are the linkages? Where is the evidence?; 2011. <http://elibrary.worldbank.org/doi/pdf/10.1596/1813-9450-5800> (03.02.14).
- [76] Korpi W, Ferrarini T, Englund S. Women's opportunities under different family policy constellations: gender, class, and inequality tradeoffs in Western Countries re-examined. *Soc Polit: Int Studi Gend State Soc* 2013;20(1):1–40.
- [77] Lehr U, O'Sullivan M. Beschäftigungsstruktur im Bereich Erneuerbarer Energien." gws Discussion Paper 09-6; 2009. <http://www.gws-os.com/discussionpapers/gws-paper09-6.pdf> [accessed 12.03.14].
- [78] Mautz R, Byzio A, Rosenbaum W. Auf dem Weg zur Energiewende. Die Entwicklung der Stromproduktion aus erneuerbaren Energien in Deutschland. Göttingen: Universitätsverlag Göttingen; 2008.
- [79] Röhr U. Geschlechterverhältnisse bei den erneuerbaren Energien – Der Blick aus dem Norden; 2002. <http://www.genanet.de/fileadmin/downloads/gm.rn04.de/Gender.RE.Industrielaender.pdf> [03.02.14].
- [80] Ruel E, Hauser RM. Explaining the gender wealth gap. *Demography* 2013;50(4):1155–76.
- [81] Schreuer A, Weismeier-Sammer D. Energy cooperatives and local ownership in the field of renewable energy technologies: a literature review; 2010. <http://epub.wu.ac.at/2897/1/Literature.Overview.energy.cooperatives.final.%282%29.pdf> [27.01.14].
- [82] Sen AK. Ökonomie für den Menschen. Wege zu Gerechtigkeit und Solidarität in der Marktwirtschaft. 2nd ed. München: Deutscher Taschenbuch Verl; 2002.
- [83] Shove E, Walker G. What is energy for? Social practice and energy demand. *Theory Cult Soc* 2014;1–18.
- [84] Sierminska EM, Frick JR, Grabka MM. Examining the gender wealth gap. *Oxford Econ Pap* 2010;62(4):669–90.
- [85] Thielmann G. Frauen im Bereich der "Erneuerbare Energien-Wirtschaft". Ergebnisse einer Umfrage bei Initiativen, Verbänden und Unternehmen; 2005. <http://www.genanet.de/fileadmin/downloads/Studien/genaS.6.EEWirtschaft.pdf> [12.03.14].
- [86] Weidner H, Mez L. German climate change policy: a success story with some flaws. *J Environ Dev* 2008;17(4):356–78.
- [87] Yildiz Ö. Financing renewable energy infrastructures via financial citizen participation – the case of Germany. *Renew Energy* 2014;68:677–85.