A Turbine is not only a Turbine: The Role of Social Context and Fairness Characteristics for the Local Acceptance of Wind Power

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Abstract: To gain acceptance for renewable energy production sites, it is not sufficient to develop the appropriate technology without taking the social context and fairness concerns into account. Using a factorial survey experiment, we investigate the influence of both on the local acceptance of wind turbine developments in Germany and Poland – two countries differing in installed wind power capacity. Respondents were surveyed with hypothetical situations describing the construction of wind farms varying in the opportunity to participate in the planning process (participatory justice), the distribution of turbines across regions (distributive justice), and ownership, among other questions. We find higher acceptance levels in Poland than in Germany. Respondents in both countries are willing to accept new turbines in their vicinity if they can participate in decision making, the turbines are owned by a group of citizens, and if the generated electricity is consumed in the region instead of being exported. Overall, participatory justice is more important than distributive justice. Confirming previous results, we also find that respondents who already have turbines in their vicinity show higher acceptance levels than those who are not yet affected. Thus, the negative externalities are likely to be overestimated in the planning and implementation process.

Keywords: Distributive Justice; Factorial Survey Experiment; Participatory Justice; Wind Power

Highlights

- A factorial survey experiment on local acceptance of wind turbines in Germany and Poland
- Attributes are comprised of procedural and distributive justice, among other factors
- Local acceptance levels of new turbines are higher in Poland than in Germany
- Opportunity to participate in planning matters more than distributive justice
- Those already exposed to turbines show higher acceptance of new wind turbines

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1. Introduction

Resistance to wind turbines can result in the foundation of a new political party. In the German state Mecklenburg-Vorpommern, the party “Free Horizon” (Freier Horizont) was founded at the beginning of 2016 and participated in the state’s election in the same year. The main issue of the party is the destruction of the landscape by a high level of wind power generation in Mecklenburg-Vorpommern. While the foundation of that party is an extreme example, across Germany there are many initiatives where citizens protest against the construction of new turbines in their vicinity. In Poland, the expansion of wind farms in recent years has produced numerous protests among local populations, which has led to the creation of several associations opposing the development of wind energy. In both countries, the extension of wind power is an important topic, and developing new projects can meet strong resistance.

On the other hand, given the unrestricted technical potential of both countries for onshore wind energy (estimates are for Germany approximately 4000 TWh and for Poland approximately 3800 TWh; EEA, 2009), and policy objectives such as combating climate change and increasing independence from foreign energy resources, both countries could generate a much larger share of electricity from onshore wind energy than they do today. For example, in Germany, the Federal German Environment Agency (UBA, 2016) assumes that in order to achieve climate policy objectives, 100% electricity generation from renewables will be needed in 2050. This would require, due to the agency’s calculations, that 2.5 GW in wind power capacity are added on a yearly basis. In Poland, the restricted technical potential of onshore wind energy is estimated at 31.5 GW in 2030 (IRENA, 2015). Reaching this level would imply an average annual increase of wind power capacity equal to 1.8 GW. These goals, even with modern turbines having large generation capacities, would need tens of thousands of new turbines across Germany and Poland. If this potential should be fully realized, then a much better understanding of the conditions of local acceptance of wind turbines would be crucial because, as Aitken (2010) is arguing, the social aspects of wind power are still not well understood. Solely pointing out the advantages of turbines, such as a CO_2-free generation of electricity, will probably not be sufficient (Wolsink, 2007a, b).

The recent literature suggests that social context is crucial, and a turbine is therefore not only a turbine, but rather a technology that's acceptance is socially embedded and affected by fairness concerns (see Wolsink 2013 for an overview). Important questions are, for example, who will own the turbines, who can participate in decision making, and what the benefits are for local communities. The majority of studies investigating the influence of these factors on local acceptance of turbines in peoples' vicinities combine qualitative interviews with standardized questionnaires comprising attitudinal items (e.g., Zoellner et al., 2008) or use only standardized questionnaires comprising sets of attitudinal items (e.g., Musall and Kuik, 2011). While responses to attitudinal items are informative, they only focus on a single aspect and are more prone to socially desirable response behavior (Liebig et al. 2015).

Another method that has recently been used to assess local acceptance of wind power developments are discrete choice experiments (DCE) (see e.g. Dimitropoulos and Kontoleon, 2009; Garcia et al., 2016). DCE use an experimental setup to elicit the preferences of respondents through choices among mutually exclusive alternatives. This way, the respondents are also less prone to socially desirable response behavior. However, a limitation for the measurement of local acceptance might be that DCE typically use a monetary attribute that often comes as a discount or rebate on the electricity bill. Respondents who are, for example, not willing to make a trade-off between a lower electricity bill and the acceptance of wind turbines in their community might not be in a position to express their opposition towards wind power development accordingly.

In this study, we use a factorial survey experiment (FSE), also called a vignette experiment, to investigate local acceptance of new turbines in Germany and Poland. To our knowledge, this is the first time that FSEs are used in this context; FSEs have mainly been used in sociology for the study of justice concerns and social norms. Similar to DCEs, FSEs are multifactorial and make it more difficult for respondents to not answer “truthfully”. Compared to simple measurements in surveys, FSEs also allow for the identification of causal effects due to the experimental setup (Auspurg and Hinz, 2015; Liebig et al. 2015). In contrast to DCEs, however, they do not use money as a common metric; respondents can express their level of agreement or disagreement on a rating scale.

While both Germany and Poland have large potentials for renewable energy production (EEA, 2009), they differ significantly with respect to the current use of wind power generation; this is an ideal situation for comparing local acceptance in countries with both high and low densities of turbines. The use of the FSE also allows avoidance of what Wolsink (2013) calls one of the main common sense biases in the debate about social acceptance. According to Wolsink (also McAdam and Boudet, 2012), the focus is too much on the potential objectors of wind power development, neglecting the supporting side, i.e. which factors lead to backing wind power developments. In this regard, fairness concerns seem to be especially relevant (Wolsink, 2007a; 2007b). In our study, we specifically consider two fairness aspects which are well grounded in the literature on environmental and social justice (Schlosberg, 2007): distributive justice (how the number of wind turbines is distributed across regions and social groups) and procedural justice (to what extent citizens can participate in decision making processes).

With respect to the comparison of Germany and Poland, we expect significant differences due to the fact that Germany can be described as a country where people frequently encounter renewable energy production sites, although the sites are unevenly distributed across the country, while in Poland people are less likely to encounter production sites. These differences across both countries can translate twofold into differences in acceptance levels. First, following a simple exposure-acceptance argument, it can be expected that a higher exposure to power plants leads to lower acceptance of *new* power plants. The reason is that there is a saturation point regarding the number of wind turbines that citizens are prepared to accept in their vicinity. Every new power plant is accordingly perceived as more disturbing than the previous one (decreasing marginal utility) and is perceived as closer to the saturation point. If this holds true, the overall acceptance should be higher in Poland than in Germany. However, previous studies also suggest a U-shaped pattern of attitudes towards wind power developments over time (Wolsink 2007a: 1197). Before a wind turbine project is planned in a region, the attitudes are positive. When a project is announced, the attitudes become more negative. After the project has been realized, the attitudes are at least as positive as before the planning process has started. Because in Germany, citizens are, in general, more likely to encounter wind turbines than in Poland, their acceptance levels regarding the construction of new turbines might be higher than in Poland, where the announcement of new turbines might lead to lower acceptance levels. Our results will show which of these explanations better describes people's stated acceptance levels.

The paper proceeds as follows. In the next section, we introduce the wind power sector in both Germany and Poland, highlighting some differences that are meaningful for the subject of our study. Subsequently, FSE as a method to elicit acceptance toward renewable energy production sites is presented before the design of our survey is introduced. Next, the descriptive statistics regarding both samples are reported, followed by the multivariate results from the FSE. Finally, we discuss our main findings.

2. Wind power in Germany and Poland

At the end of 2015, the installed wind energy capacity in the European Union (EU) was estimated to be 142 GW. While Germany's share of this capacity was about 32% (about 45 GW, see Table 1), Poland's share was about 3.6 % (about 5.1 GW; EWEA, 2016). From these figures, Germany is the EU country with the largest installed capacity, while Poland is in 7th place among EU members.[1] Although the wind power potential is comparable in both countries (EEA, 2009), the figures reveal a large gap concerning the installed capacity. One reason[2] for this gap is that each country started promoting the expansion of renewable energies at different points in time. Germany began in the early 1990s with the renewable energy act and with feed-in-tariffs. Poland, in contrast, implemented its system to support renewable energy, using certificates, not before 2005.

At the end of 2015, electricity from renewable energy sources was an important part of the energy mix in Germany, with wind taking the largest share of 12.3% (79.2 TWh; 70.9 TWh onshore, 8.3 TWh offshore). The share of electricity generated from wind in Poland is about half of the share in Germany. However, it is worth noting that the number of wind power installations in Poland has recently increased rapidly. In 2015, with 1.3 GW new wind capacity installed, Poland was the second in the EU in terms of wind energy development, after Germany. In that year, wind farms in Poland also broke a record by generating 10 TWh electricity – an increase of 40% compared to 2014 (PWEA, 2016).

Following the significantly different amounts of installed capacity, exposure to turbines is very different in both countries (Table 1). This is indicated by the density measurement of turbines per 100 km^2. While in Germany there have been 7.3 turbines per 100 km^2 at the end of 2015,

[1] Countries placed between Germany and Poland are: Spain (23 GW), UK (13.6 GW), France (10.4 GW), Italy (9 GW) and Sweden (6 GW).

[2] For a review of the regulatory framework and how it promotes the expansion of wind power across EU countries, see González and Lacal-Arántegui (2016).

this density for Poland is 0.8 turbines per 100 km^2. Thus, people in Poland are, on average, less likely to encounter turbines in their vicinity.

[Table 1 about here]

The latest figures concerning the ownership structure of wind power in Germany are from 2012 (trend: research & Leuphana Universität Lüneburg 2013). According to this study, about 25% of the installed capacity was owned by citizens (single owners and citizen-owned energy companies). If trans-regional citizen-owned wind power is added to this figure, the share increased in 2012 to roughly 50%. In contrast, institutional and strategic investors owned 39% of the installed capacity. Energy suppliers ranked third with a share of 10%. In Poland, on the other hand, the majority of wind farms are owned by independent power producers (mostly foreign companies). Nineteen percent of the installed capacity of wind farms in Poland is owned by a few state-owned companies (PWEA, 2016).

3. Factorial Survey Experiments

Factorial Survey Experiments (FSE), also called vignette experiments, are a multi-factorial survey method that was introduced by Rossi and Lazarsfeld in the 1950s (Rossi, 1979). Since the 1970s, FSE has become an important method in sociology for the study of justice concerns and social norms, among other issues (see Jasso and Rossi, 1977; Jasso and Opp, 1997; Wallander, 2009; Auspurg and Hinz, 2015). In FSE, respondents face one or more descriptions of a situation (i.e. vignettes) that differ from each other in a discrete number of attributes (or factors). The respondents are then asked to evaluate those situations according to criteria such as support, agreement, or perceived fairness. Due to the systematic variation of the factors or situational attributes presented in the situations, a FSE is an experimental setup which can separate effects of single situational dimensions. Thus, the causal influence of relevant situational attributes can be determined. Further, FSEs measure beliefs, social norms, and judgments in an elegant way, because they do not measure the concepts directly via single survey items, but rather indirectly, based on the relevance of corresponding situational variables. This indirect measurement also lowers socially desirable response behavior (Auspurg et al., 2015). In multivariate regression analyses, the evaluations are included as dependent variables and the factors/situational attributes as independent variables (e.g., Jasso, 2006).

Designing and conducting a FSE requires, similar to a DCE, at least the following steps (see Auspurg and Hinz 2015 for details and state-of-the art guidelines): First, the number of attributes or characteristics of a situation has to be decided and attribute levels have to be assigned. Combining all possible attribute combinations gives the so-called full factorial, the number of possible situations respondents can judge. If a factorial survey study comprises many attributes, this number is often too large to present to all respondents. Therefore, secondly, if this situation applies, an experimental design is used to reduce the number of vignettes that respondents face, and at the same time, it should still be possible to separate the effects of single factors. Third, researchers have to choose a response scale for recording respondents' judgments (e.g., five-point, seven-point, or eleven-point response scales), and, fourth, there are different statistical models that can be used to analyze FSE data. Usually, as in this study, respondents answer several vignettes, and the judgments per individual are probably not independent of each other and are correlated. There exist different methods (e.g. clustered standard errors; random effects and mixed effects regression models) to account for such correlations.

4. Design of the Factorial Survey Experiment

In our FSE, respondents were confronted with vignettes in which the construction of a wind farm is planned in the 10 km around the respondent's place of residence. This wind farm project and its characteristics were described with six attributes (factors) that varied in their attribute levels across vignettes. The attributes were chosen in accordance with theoretical considerations on distributional and procedural justice (Schlosberg, 2007; Wolsink, 2007a, b), in line with previous qualitative research in this area (Langer et al., 2016) and political and societal debates about renewable energy expansion. Finally, we drew on knowledge from focus groups we had conducted in both Germany and Poland in connection with previous surveys about renewable energy (Bartczak et al., 2016; Oehlmann and Meyerhoff, 2017).

On this basis, we first include in the vignettes the attribute "number of turbines" (6, 15 or 25), that reflects the magnitude of exposure and potential negative externalities of wind turbines (Dimitropoulos and Kontoleon, 2009). With respect to distributive justice (Schlosberg, 2007; Langer et al., 2016 for energy production), we refer to the equal and unequal distribution of the number of wind farms across regions (less, equal or more wind farm in the respondent's region compared with other regions in Germany/Poland). Procedural justice (Schlosberg, 2007; Wolsink, 2007a, b; Zoellner et al., 2008; Langer et al., 2016) is captured by the vignette attribute "possibility to participate" (possible vs. not possible). Further attributes refer to the ownership structure (Devine-Wright, 2005; Langer et al., 2016), as well as the use of the revenues. We therefore vary the "investor" of the project (municipal utility, non-local investor, citizen-owned wind farm), whether the produced energy will be used in the region or for export, and whether the tax revenues of the wind farm will be used for public purposes or private purposes (i.e., promoting energy saving in private households). Table 2 gives an overview of the attributes and their levels.

The full factorial – all possible attribute-level combinations – comprises 216 (=3x3x2x2x2x3) possible vignettes. Using the software NGene (ChoiceMetrics, 2014), we generated a fractional factorial design in order to reduce the number of sets. As a final design, we use an orthogonal design with two-way interactions in which the attributes vary independently of each other within and across vignettes. The two-way interactions were created using the fold-over technique (ChoiceMetrics, 2014: 76). This resulted in 72 vignettes. Each respondent was presented four vignettes that were randomly drawn from those 72 vignettes without replacement. Answers were provided on an 11-point ordered rating scale. Such scales are most frequently used in factorial survey studies because they give sufficient possibilities for respondents to express differences in vignette judgments, and they prevent risks of censored responses (Wallander, 2009; Auspurg and Hinz, 2015: 69). Compared to nominal scales, magnitude response scales, and direct questions, these scales are also less prone to missing values and outliers.

We use random effects regression models that take the nested structure of the data (each respondent answers four vignettes), as well as differences between respondents, into account. Using an ordinary least squares regression and ignoring the fact that respondents judge multiple vignettes will result in biased standard errors of the coefficients in the model (Snijders and Bosker, 2012). We employ the random intercept model as a variant of the random effects regression model. In this model, it is assumed that respondents "express different (individual) thresholds" of vignette acceptance levels (Auspurg and Hinz, 2015: 90). Likelihood-ratio tests show that in our study such a model specification is preferred over an ordinary least square regression model.

[Table 2 about here]

[Figure 1 about here]

5. Sample and Descriptive Statistics

We implemented the FSE in an online survey that was conducted in March 2016 in Germany and Poland. The more than 1,800 respondents (900+ per country) were members of an access panel of a survey organization. Table 3 gives an overview of the sample characteristics and some additional individual variables that are helpful to explain heterogeneity in the acceptance of wind farm projects. We include all respondents who do not have any missing values for the variables considered in the present paper. It should be noted that these samples are not representative of the general populations in Germany and Poland. For example, women are underrepresented in Germany and overrepresented in Poland, and there is a bias towards younger and better educated individuals, as in most online surveys. Despite this issue, Table 3 shows that we have sufficient variance for each variable in order to investigate differences between social groups (gender, education, income etc.). This is especially important regarding the place of residence, because turbines are generally built in rural areas. Regarding people's residency, 29% of the respondents in the German sample and 31% of the respondents in the Polish sample live in rural areas and towns with up to 20,000 inhabitants. Moreover, comparing the samples in Table 3, the difference in house/flat ownership is striking. In Poland, 80% of the respondents own the house/flat they live in. With 34% ownership, this value is much lower in Germany, and reflects that fact that Germany is a "rental market" and Poland a "buying market."

Further, we asked the respondents whether they already have wind turbines near their place of residence. Around half of the German, and one third of the Polish, respondents state that they do have wind turbines in their vicinity; 32% (Germany) and 41% (Poland) stated they do not have any turbines nearby, and 17% (Germany) and 24% (Poland) expressed that they do not know whether turbines are nearby. The higher figures of wind farm exposure in Germany are plausible because at the time of the survey, Germany had a considerable higher share of wind energy production, and thus many more installed turbines than Poland (as pointed out in the introduction).

[Table 3 about here]

6. Results

Overall Acceptance Levels

Figure 2 shows a comparison of the German and Polish samples, regarding the overall acceptance of the wind farm projects presented in the vignettes. The graph shows that the general acceptance of the proposed wind farm projects is higher in the Polish sample. Values below six, the midpoint of the acceptance response scale, have lower proportions in the Polish sample than in the German sample. Values above six were chosen more frequently in the Polish sample, especially in the case of the endpoint of the scale representing a "total acceptance" of the wind farm projects. Accordingly, the mean acceptance level in the German sample is 6.59 (SD = 0.05, n = 890), and in the Polish sample is 7.83 (SD = 0.05, n = 912). This difference is highly statistically significant ($p<0.0001$ based on a two-sided t-Test, a Mann-Whitney test, and a bivariate random effects regression).

While in both samples the majority of respondents is willing to accept the proposed wind farm project, these descriptive figures point to important differences across both countries. Within each country, responses vary across the whole response scale, which indicates that the vignette attributes have explanatory power for the acceptance levels. In other words, the acceptance seems to depend on the attributes and attribute levels that vary across vignettes.

[Figure 2 about here]

Multivariate analysis

Table 4 presents the results of the random effects regression models, i.e. random intercept models, separately for the German and the Polish samples. The models G1 and P1 include the vignette attributes, and G2 and P2 add the respondents' characteristics. For all four models, likelihood-ratio tests show that the latter model specification is preferred over an ordinary least square regression model (all test with $p<0.0001$). Further, we do not find any relevant interaction effects between the vignette attributes; hence, we focus on the main effects. The intra-class correlations for the German and Polish samples are 0.697 and 0.786 in models G1 and P1, respectively, and indicate a high correlation of the four responses per respondent. In both samples, acceptance levels are lower if the proposed wind farm project includes a larger number of turbines (15 and 25 turbines compared to 6 turbines, the reference level). The effects are stronger in the Polish sample compared with the German sample. While the Polish respondents do not evaluate an external investor and municipal utility provider significantly differently, they are in favor of citizen-owned wind farms. In the German sample, both the municipal utility provider and the citizen-owned wind farm are accepted significantly more than a non-local investor. This seems to be in line with the positive evaluation of the regional use of the generated electricity compared to exporting the electricity. This "region effect" is more pronounced in the German sample than in the Polish sample.

The strongest effect across the two samples can be found for the opportunity to participate in the decision making process. The acceptance level is considerably higher when citizens are involved in the decision making process. While the Polish respondents make no difference between using the tax revenue of the wind farm for private or public purposes, the German respondents are strongly in favor of the private purpose, i.e., supporting energy saving programs in private households. Further, distributional justice on the regional level only matters in the German sample and the effects are weakly statistically significant (i.e. $p<0.10$). If the wind farm leads to having more wind farms in the local region, compared with other regions in Germany, the acceptance of the project decreases significantly. However, it does not affect acceptance levels if there are less wind farms in the respondent's region compared with other regions in Germany.

A pooled random effects model, including country variables and interaction effects between the country and the vignette attributes (see the appendix), reveals that, next to an overall significantly higher acceptance level in the Polish sample, the effects of municipal utility production and the citizen-owned wind farm, as well as the regional use of energy and usage of tax revenues for private purposes, are significantly weaker in the Polish sample compared with the German sample.

[Table 4 about here]

The Models G2 and P2 in Table 4 contain the effects of socio-demographic and individual characteristics to capture further heterogeneity in the overall acceptance of the wind farm project described in the vignettes, in addition to the attribute effects. Due to the experimental character of the factorial survey, the attribute effects show the same pattern as in the Models G1 and P1. Contrary to what might be expected, we do not find many statistically significant effects for the socio-demographic variables sex, age, education, income, and place of residence. Those factors that are statistically significant vary between both samples and are as follows: in Poland women show a significant lower acceptance of the wind farm projects compared with men. Compared with a medium income level, in the German sample both those with a lower and a higher income are more in favor of the wind farm projects, independent of the attributes in the vignettes. This suggests a non-linear effect of income on the acceptance in the German sample. In Poland, household income seems not to be a relevant predictor. Yet the subjective financial situation has a significant and positive effect on acceptance; those who perceive themselves to be better off are more in favor of the wind farm projects.

While it is clear that citizens living in rural areas are, and will be, more exposed to renewable energy projects, we do not see much difference in the overall acceptance of wind farm projects. While all effects of town size are positive in the models G2 and P2, in the Polish sample, respondents in larger towns (100,001 to 500,000 inhabitants) show a statistically significantly higher acceptance rate. In turn, respondents living in rural areas (the reference category) are less in favor of the projects described in the vignettes. Given the ongoing debate about to what magnitude the extension of renewable energy influences property values, those who own a house or flat do not judge the vignettes significantly differently than those who rent a house or flat. This holds true in both country samples, albeit the housing markets in Germany and Poland are quite different with respect to the share of owned property (rental vs. buying market). We see two effects that are statistically significant and present in both country samples: compared with those who state they do not have wind turbines in their vicinity, respondents who are aware of turbines in their vicinity and those who do not know whether there are turbines near their place of residence show a higher acceptance level of the proposed wind farm projects. This is in line with previous findings in the literature indicating that individuals who are exposed to wind turbines have a more positive attitude towards wind energy, compared with individuals who are not affected (see e.g. Wolsink, 2007a; Langer et al., 2016).

7. Discussion, Conclusions and Policy Implications

The major finding of the present paper, adding to the literature on the social acceptance of renewables, is that the local acceptance of renewable energy depends on specific social context and fairness concerns, which we are able to single out. Our results support the view that it is not sufficient to develop the appropriate technology without taking the social factors of local acceptance into account. While the local conditions may vary considerably within and between countries, our survey-based experiment suggests at least four aspects which are crucial for the local acceptance of renewable energy; in our case, wind farms. These factors show stable and remarkable effects in the German and Polish samples. First, citizens show higher acceptance levels when they have the opportunity to participate in the decision making process regarding the implementation of a specific renewable energy project. This is in line with procedural justice as discussed in the literature on environmental justice (e.g., Schlosberg, 2007; Wolsink, 2007 a, b), and was also found in stated choice experiment studies on the acceptance of wind power projects (e.g., Dimitropoulos and Kontoleon, 2009). Second, the possibility that the wind farm is owned by the citizens themselves is valued positively in both countries. Thus, policy makers and project developers may consider simplifying such ownership structures in order to increase support for renewable energy extension. Third, our findings suggest that citizens are in favor of consuming the electricity produced in their vicinity in their region instead of exporting it to other regions. From a technical point of view, there is no difference in quality of locally produced electricity compared with imported electricity. However, there seems to be a strong (social-) psychological component involved in the sense that citizens value "regionalism." Regional identity (Paasi, 2003) might therefore be of importance and lead to the desire to "directly" benefit from using the landscape for wind power development in the own region. Fourth, the size of a wind farm matters. Citizens prefer smaller wind farms, i.e., farms with six turbines compared to farms with 15 or 25 turbines. All four points, indicating which factors could have a supporting effect, can be taken up in decision making and addressed when new renewable energy projects are planned. It should be noted that reducing the number of turbines in a wind farm can quickly affect the profitability of a project and might not always be an option.

Another major insight from our study is that distributional justice is less relevant than the four aspects mentioned above. However, there is a tendency that it matters more in the German sample compared to the Polish sample. Citizens who have, on average, more wind farms in their region than in others regions in Germany show a lower acceptance for new wind farm projects in their surroundings. Having fewer wind farms in their own region, compared with other regions, does not considerably affect acceptance levels. The non-significant effect of distributional justice in the Polish sample might be explained by the comparable low exposure to wind turbines. In Germany, exposure is much higher, and the regional distribution of renewable energy production is a much discussed and well-known topic on the political agenda. However, our study clearly indicates that regarding renewable energy extension, it would be misleading to focus primarily on distributional aspects, often combined together with financial compensations at the regional level (such as monetary transfers from one region to the other), in order to compensate for higher exposure levels to negative externalities from renewable energy; from the citizens' point of view, there are other justice concerns, such as procedural aspects, which seem to be much more important.

While we do not find strong rural-urban differences in the acceptance of wind farm projects, our findings support previous research (Wolsink, 2007a; Langer, et al. 2106) which has shown that individuals who are already exposed to renewable energy plants show a more positive attitude and higher acceptance levels towards renewable energy than those who are not yet affected by renewable energy production in their vicinity. We find this effect in both country samples, and also for those who state that they do not know whether they already have wind turbines in their surroundings. This suggests that the strongest reservations towards renewable energy projects can be found by those who are aware that they are currently *not* affected by turbines. These citizens might have lower acceptance levels with respect to new power plants because they might give a higher weight to potential negative externalities of these plants.

It should be noted that in our study, the effect of exposure of renewables on acceptance is derived from cross-sectional data, and ideally we need longitudinal data to study the change in attitudes and acceptance levels over time when individuals face the planning, construction, and implementation of new plants. We use wind power as an example, and future studies might also include other renewable energy sources. It cannot be ruled out that the acceptance and social context and fairness effects differ regarding energy sources.

Researchers and experts have been aware for many years that the local acceptance of renewable energy extension depends on different factors. The political party “Free Horizon”, which we mentioned at the beginning of this paper, received less than one percent of the votes in the federal election in the German federal state Mecklenburg-Vorpommern in 2016. This indicates, in line with our findings, that acceptance of wind power is higher than the foundation of this party suggested. With respect to Poland, our study shows overall high acceptance levels for wind turbines. Instead of building up on this high acceptance, however, in 2016, the Polish government implemented a very restrictive policy on wind power that already slowed down investments in this sector. Whether this policy is motivated by expected protests against new turbines, or by other policy objectives, such as promoting traditional energy sources (including coal), is a question that we cannot answer here. Overall, it seems wrong to think in a dichotomy of “accept” or “object.” Rather, different factors seem to affect acceptance levels of wind turbines to a varying extent. Using a multifactorial survey-based experiment, our study demonstrates how such factors of acceptance can be found and singled out. Our findings, as well as the methodological toolkit presented in this paper, might give valuable insights for scientists and (political) decision-makers alike.

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Appendix

[Table A1 about here]

Table 1: Wind power in Germany and Poland at the end of 2015

	Germany	Poland
Total installed capacity in GW	44.9	5.1
Installed capacity per capita in W	553.7	132.5
Generated electricity in TWh	79.2	10.0
Share of total electricity generation in %	12.3	6.2
Capacity per turbine in MW	1.7	2.0*
Number of turbines installed	25,980	2,550*
Number of turbines per 100 km^2	7.3	0.8*

Source: EWEA 2016, PWEA, 2016, *own calculations.

Table 2: Attributes and Attribute Levels in the Factorial Survey Experiment

Attribute	Levels
Number of turbines	6 turbines (12 ha) / 15 turbines (30 ha) / 25 turbines (60 ha)
Investor	municipal utility / a non-local investor / a group of citizens from the surrounding area (citizen-owned wind farm)
Electricity use	consumed in the region / exported to other regions
Opportunity to participate in planning	cannot have a say / have a say in every step of the planning process
Tax revenue	revenue goes into the general budget of your municipality / used for promoting energy-saving measures in private households in the municipality
Number of turbines per regions	less / the same number / more turbines in respondents' region than in other regions in Germany/Poland

Table 3: Overview on characteristics for the German (n=889) and Polish samples (n=912)

	German sample Mean(Sdv)	Min	Max	Polish sample Mean(Sdv)	Min	Max
Gender (1=women)	0.50 (0.50)	0	1	0.55 (0.50)	0	1
Age in years	43.39 (14.68)	18	93	42.24 (13.12)	18	98
Education in years	12.93 (3.50)	7	18	14.42 (2.24)	6	17
Household size	2.28 (1.13)	1	7	3.08 (1.22)	1	7
Low income (below the range of average household income per country*)	0.28 (0.45)	0	1	0.41 (0.49)	0	1
Medium income (in the range of average household income per country*)	0.33 (0.47)	0	1	0.32 (0.44)	0	1
High income (above the range of average household income per country*)	0.39 (0.49)	0	1	0.27 (0.44)	0	1
Perceived financial situation (1=very bad, 4=very good)	2.60 (0.77)	1	4	2.55 (0.66)	1	4
Town size up to 20,000 inhabitants	0.29 (0.45)	0	1	0.31 (0.46)	0	1
Town size 20,001 to 100,000 inh.	0.21 (0.49)	0	1	0.22 (0.41)	0	1
Town size 100,001 to 500,000 inh.	0.24 (0.42)	0	1	0.24 (0.43)	0	1
Town size over 500,000 inhabitants	0.26 (0.44)	0	1	0.23 (0.42)	0	1
Owns house/flat (1=yes)	0.34 (0.47)	0	1	0.80 (0.40)	0	1
Wind turbine nearby	0.51 (0.50)	0	1	0.35 (0.48)	0	1
No wind turbine nearby	0.32 (0.47)	0	1	0.41 (0.49)	0	1
Don’t know whether wind turbine nearby	0.17 (0.37)	0	1	0.24 (0.43)	0	1

Note: * The range of average household income per country was calculated based on a categorical income variable as “2,001 to 3,600 Euro” for Germany (= medium income) and “686 to 1,143” Euro for Poland.

Table 4: Results of Random Effects Regression Models for the Vignette Attributes and Heterogeneity Variables, separately per Country

Variables	Germany G1	Poland P1	Germany G2	Poland P2
15 turbines (vs. 6)	-0.124	-0.232**	-0.116	-0.232**
	(-1.55)	(-3.67)	(-1.44)	(-3.68)
25 turbines (vs. 6)	-0.186*	-0.291**	-0.180*	-0.291**
	(-2.32)	(-4.64)	(-2.24)	(-4.65)
Municipal utility	0.366**	0.067	0.364**	0.069
	(4.53)	(1.07)	(4.51)	(1.10)
Citizen owned	0.359**	0.125*	0.357**	0.128*
	(4.39)	(2.00)	(4.38)	(2.06)
Regional use (vs. exp.)	0.472**	0.152**	0.475**	0.153**
	(7.16)	(2.98)	(7.20)	(3.00)
Participation (vs. not)	0.510**	0.388**	0.511**	0.388**
	(7.79)	(7.64)	(7.80)	(7.63)
Tax use priv. (vs. publ.)	0.231**	-0.038	0.229**	-0.039
	(3.52)	(-0.73)	(3.49)	(-0.75)
Less turb./region (vs. equal)	-0.068	-0.058	-0.064	-0.058
	(-0.85)	(-0.92)	(-0.80)	(-0.93)
More turb./region (vs. equal)	-0.148^{+}	-0.026	-0.146^{+}	-0.028
	(-1.85)	(-0.43)	(-1.83)	(-0.45)
Women (vs. men)			0.047	-0.452*
			(0.25)	(-2.48)
Age in years			-0.023**	0.015*
			(-3.54)	(2.13)
Education in years			0.013	0.018
			(0.47)	(0.42)
Household size			0.109	0.036
			(1.19)	(0.45)
Low income (vs. middle)			0.417^{+}	-0.026
			(1.69)	(-0.12)
High income (vs. middle)			0.420^{+}	0.339
			(1.82)	(1.41)
Personal financial situation			0.172	0.290*
			(1.33)	(1.97)
Town size 20,001 to 100,000			0.259	0.196
(vs. up to 20,000)			(0.99)	(0.78)
Town size 100,001 to 500,000			0.144	0.479^{+}
(vs. up to 20,000)			(0.55)	(1.90)
Town size over 500,000			0.160	0.310
(vs. up to 20,000)			(0.61)	(1.17)
Owns house/flat (vs. rent)			-0.307	-0.289
			(-1.43)	(-1.24)
Turbines in vicinity, yes (vs. no)			1.013**	0.664**
			(4.88)	(3.20)
Turbines in vicinity, don't know			0.718**	0.448^{+}
			(2.58)	(1.94)
Constant	5.914**	7.714**	5.082**	5.792**
	(43.88)	(65.23)	(7.17)	(6.28)
Number vignettes	3,556	3,648	3,556	3,648
Number resp.	889	912	889	912
Log Likelihood	-8,010.317	-7,540.524	-7,982.059	-7,519.505
Std Dev random effect	2.614	2.599	2.523	2.537
Std Dev error	1.721	1.357	1.721	1.355
Intra-class corr.	0.697	0.786	0.682	0.778

Note: $^{+}$ p<0.10; * p<0.05; ** p<0.01, Presented are unstandardized coefficients and 95% confidence intervals from random parameter regression models, separately for Germany (n=889) and Poland (n=912).

Table A1: Results of Random Effects Regression Models for the Vignette Attributes, Pooled Model

Variables	Pooled Model for Germany and Poland
15 turbines (vs. 6)	-0.130^{+}
	(-1.80)
25 turbines (vs. 6)	-0.190**
	(-2.63)
Municipal utility	0.364**
	(5.02)
Citizen owned	0.357**
	(4.86)
Regional use (vs. export.)	0.473**
	(7.98)
Participation (vs. not)	0.509**
	(8.65)
Tax use private (vs. public purpose)	0.230**
	(3.90)
Less turb./region (vs. equal)	-0.067
	(-0.92)
More turb./region (vs. equal)	-0.149*
	(-2.07)
*Pol*and (vs. Germany)	1.797**
	(10.04)
Pol x 15 turbines (vs. 6)	-0.100
	(-0.98)
Pol x 25 turbines (vs. 6)	-0.101
	(-1.00)
Pol x Municipal utility	-0.297**
	(-2.92)
Pol x Citizen owned	-0.234*
	(-2.30)
Pol x Regional use (vs. exp.)	-0.324**
	(-3.90)
Pol x Participation (vs. not)	-0.117
	(1.42)
Pol x Tax use priv. (vs. publ.)	-0.267**
	(-3.21)
Pol x Less turb./region (vs. equal)	0.007
	(0.07)
Pol x More turb./region (vs. equal)	0.120
	(1.19)
Constant	5.92**
	(46.63)
Number vignettes	7,204
Number resp.	1,801
Log Likelihood	-1,5627.973
Std Dev random effect	2.607
Std Dev error	1.547
Intra-class corr.	0.740

Notes: $^{+}$ p<0.10; * p<0.05; ** p<0.01.