Papers in Evolutionary Economic Geography

21.19

Blowing against the winds of change? The relationship between anti-wind initiatives and wind turbines in Germany

Manuel Gardt, Tom Brökel & Philipp Gareis

Utrecht University Human Geography and Planning

Blowing against the winds of change? The relationship between anti-wind initiatives and wind turbines in Germany

Manuel Gardt[1], Tom Brökel[2], Philipp Gareis[3]

Abstract:

This study analyzes the formation and spatial structure of anti-wind-farm citizens' initiatives (CIs) as a result of the development of wind turbine generators (WT) in Germany over the last three decades. It offers a novel, spatiotemporal view of the intensely discussed tension between WT and citizens' perceptions of them. Using a new dataset and employing survival models, the study explores for the first time the co-development of WT and anti-wind initiatives, considering a wide range of regional socio-economic factors and multiple periods. The results confirm a rapidly growing dynamic of the establishment of local opposition, which the magnitude of locally existing WT and proximity to established anti-wind farm initiatives strongly drives.

Keywords:

Local opposition, wind energy development, Germany, citizens' initiatives, acceptance, survival analysis

JEL classification: C54; O18; O33; R11; R15; R59

[1] juwi AG, Energie-Allee 1, 55286 Wörrstadt, Germany. Email: manuel.gardt@juwi.de
[2] Department of Innovation, Management and Marketing, University of Stavanger,Business School, Stavanger, Stavanger, Norway. Email: tom.brokel@uis.no
[3] Department of Urban Geography and Spatial Planning, University of Giessen, Giessen, Germany. Email: philipp.gareis@geogr.uni-giessen.de

1. Introduction

In recent years, the use of renewable energies has become one of the most promising approaches to mitigating the negative effects of climate change. A key pillar in this process is the expansion of wind energy, a major contribution to the supply of CO_2-neutral electricity generation [1]. However, while wind energy in Germany has developed strongly over the last two decades, the construction of new wind turbine generators (WT) has stagnated since 2017, due to strict rules for planning new WT and to successful protest [2]. The number of newly installed WT has fallen to its level prior to the introduction of the Renewable Energies Act in 2000 [3]. The reasons for this are manifold and attributable inter alia to the amendment of the funding conditions, as well as complex approval procedures and political land restrictions. Also, the seemingly dwindling public acceptance [4] seems to increasingly dominate the discussion about wind-energy expansion in Germany [5] and many other countries [6, 7, 8]. While wind energy generally had high levels of social support at the time of the first scientific surveys [9, 10, 11, 12], the increasing number of WT from 9,000 in the year 2000 to approximately 30,000 in 2020 [13] has given rise to more negative public sentiments, in particular among individuals living close to them [14]. The contemporary literature has extensively debated this "gap" [15] between generally high social acceptance of wind energy and the growing local resistance toward particular projects. However, existing research differs greatly in terms of spatial scale (project-based to country-level) and theoretical approaches (social justice to NIMBY debates) [15, 16, 17, 18, 19, 20, 21, 22].

The aim of our investigation is to identify the role of regional factors in the formation of anti-wind citizen initiatives (CIs), as well as their influence on the erection of new WT. Therefore, our analysis extends the contemporary literature by examining the formation of local opposition towards WT in Germany, from a spatial and temporal perspective. We simultaneously analyze the fundamental relationship of spatial and structural factors in the construction of WT to the formation of a CI against WT and quantify the field of tension between these two. While the literature has already discussed in depth the underlying mechanisms of rejecting WT [7, 23, 24, 25, 26,], it offers only rudimentary insights into the spatial emergence of anti-wind-farm protests and the attendant significance of socio-spatial factors.

The present study addresses this gap using a novel data set on German municipalities and survival regressions. More precisely, we investigate whether and, if so, to what extent the construction of WT promotes the subsequent formation of CIs. We also test whether established initiatives impact the construction of new WT and self-reinforcing neighborhood effects characterize the formation of CIs.

Our study features a comprehensive overview of the past and current spatiotemporal structure of CIs and confirms a rapidly growing dynamic of local opposition in relation to the expansion of wind energy in Germany. We also quantify the influence of spatial and structural factors on the construction of WT and the formation of local opposition and their spatial-impact radius. Our findings confirm that CIs could form as a reaction to new WT, especially in the vicinity of ~10 km, and they have a strong negative influence on the construction of new WT in their surroundings.

The paper's structure is as follows. Section 1 reviews the underlying theoretical approach to understanding the acceptance of WT (chapter 1.1) and presents corresponding empirical evidence for Germany (chapter 1.2). Chapter 2 features a detailed description of our novel data set, its origin and structure, as well as additional variables we used. In chapter 3, we introduce our methodological approach, and chapter 4 presents our findings. In chapter 5, we conclude our study by expressing recommendations for further action.

1.1. Acceptance of WT and formation of local opposition

While the German public generally perceives positively the development of renewable energies [27, 28, 29] and wind energy in particular [29], sentiment concerning the establishment of new WT at the local level has become increasingly negative in recent years [14, 30, 31]. In many cases, this has translated into active anti-wind-turbines protest movements that not only oppose the (local) construction of WT but also reject acceptance-promoting planning approaches [9]. Consequently, project developers must consider in advance the social and nontechnical challenges [32] that increasingly determine the local population's acceptance of built WT.

As is the case for any other spatially significant land use, WT induce a wide range of direct and indirect effects that may raise conflicts with the local population [7]. According to Wüstenhagen et al. [28] and Langer et al. [29], the several reasons for rejecting WT fall into categories of those relating to "personal characteristics," "technical and geographical issues," and "perceived side effects." For instance, Jobert et al. [35] show that while participation instruments can mitigate conflict-ridden planning processes, the general perception of WT is of so-called "Locally Unwanted Land Uses" (LULUs) (see also [36]). Consequently, the local population tends to reject them [37, 38]. According to Popper [39], LULUs are technical installations that are necessary from a regional or national perspective but have a permanent (or, at least, long-lasting) negative impact on their immediate environment, and therefore, the local population rejects them. Conceptualizing WT as LULUs provides a more complete and less distorted perspective than the rather one-dimensional [40] and negatively biased [17, 19] idea of the NIMBY syndrome. Swofford/Slattery [25] even recommend "abandoning the use of the term at media, institutional and decision-making levels."

WT in Germany are a prime example of LULUs, as national aims to increase renewable energy production promote and support them, but the local population may perceive them as oppressive, due to their adverse effects. According to Selle [36], such a spatial conflict may produce "losers" and will therefore "always encounter sustainable resistance," due to the fact that some places are highly suitable for WT installation because of high wind speeds. As they maintain the minimum distance to residential and other relevant buildings, WT are often highly concentrated in specific areas. Therefore, a fair distribution of WT across the country is nonexistent and they affect the rural more than the urban population. Also, most local people do not participate in the economic success of the installation and operation of WT, leading to even lower acceptance rates [41]. However, the mindset of the population, project leaders' participation processes, and adaptation to history and local characteristics in the planning process strongly shape WT acceptance [42]. Consequently, experiencing procedural justice differs greatly across space and time, and (possible) installation of WT does not automatically lead to new CIs. Other examples of LULUs are conventional power plants, large farms, waste treatment plants, radio stations, and disposal facilities [43].

Numerous recent studies evaluate the influence of acceptance on the success of renewable energy projects [17, 20, 21, 22, 33]. However, there is not yet a uniformly shared understanding of acceptance, nor will there ever be, due to the history of places and the attitudes of local populations [42, 44].

In the present study, we built on the work of Langer et al. [34], which proposes a generalizing framework for the "triangle of social acceptance," based on Wüstenhagen et al. [33]. Accordingly, social acceptance represents "the degree of which a phenomenon is taken by relevant social actors, based on the degree how the phenomenon is (dis-)liked by these actors" [45, p. 1785]. Wüstenhagen et al. [33] further dissect this term into three more precisely defined forms, namely, socio-political acceptance, market acceptance, and community acceptance. Socio-political and market acceptance are generalized forms that political decision-makers, consumers, and stakeholders shape. Community acceptance is highly individual and dependent on the planned project.

Furthermore, the acceptance of WT has side effects that we must discuss. The effect of WT on landscape attractiveness is highly ambiguous, even though tourists seem to prefer less artificial landscapes [46]. Visual and noise emissions are also side effects of WT, which can influence the local population and visitors or even affect bird and bat mortality (Wang/Wang 2015). CIs capture these effects, which become core arguments in the protest against WT.

1.2. Empirical evidence for Germany

The past and contemporary literature that relates to the acceptance of WT and the role of regional characteristics is rather heterogeneous, in terms of perspective and methodological approaches. Following is a summary of the most important contributions to German acceptance of WT, to better explain the dynamics of renewable-energy acceptance during the transformation of the energy sector.

The study by Zoellner et al. [30] analyzes the degree of acceptance of different types of renewable energies (photovoltaic, biomass, and WT), using a multidimensional methodology. The spatial focus of the study lies on four case-study regions (East Germany, Southwest Germany, West Germany, and Northeastern Germany), with WT investigations occurring primarily in West Germany. The interdisciplinary study combines both qualitative and quantitative research methods, including qualitative interviews, standardized questionnaires, and regression analyses. Its key findings confirm a generally high level of acceptance of WT. However, at the local level, social, procedural, and economic justice impact local acceptance.

Musall/Kuik [48] discuss the question of unequal acceptance levels. They use two case studies to examine the influence of ownership on the approval of local stakeholders. The interview-based survey of 200 directly impacted residents took place in two comparable municipalities in the federal state of Saxony. The authors conclude that direct financial project participation in the sense of a "community wind farm" has positive effects on acceptance in general. Comparable studies [41, 49, 50, 51] support this finding in an international context.

In the district of North Frisia, packed with WT, the study by Süsser/Kannen [52] deals with the stakeholders' perception of renewable-energy plants in one municipality. The analysis contains a mix of methods, including a planning-document analysis with support from two series of semistructured interviews (n = 15) and a household survey (n = 51), to answer the question of the extent to which the use of WT changes the perception of the communities' social aspects. The interviews revealed an enhancement of community spirit through citizens' involvement, which affected the acceptance of existing projects directly and fostered the intrinsic motivation to realize additional projects.

The federal state of Bavaria, strongly characterized by country-specific planning regulations, is the subject of the study by Langer et al. [34], whose primary research objective is the question of which factors influence WT acceptance. These characteristics were based on a comprehensive literature search, supplemented by semistructured interviews with leaders of wind-energy supporter and opponent groups in the course of the research. The study confirms the classification of Wüstenhagen et al. [33] and recognizes that both active participation and previous experience with WT positively impact local acceptance. Representatives of the CIs particularly articulated inhibiting factors, primarily pointing out the unequal burden of WT within the individual regions and accordingly representing a distributional injustice, in the sense that Gross [53], Walker/Baxter [54] and Frate et al. [55] use it.

Another interesting case study is by Reusswig et al. [4], analyzing the processual relationship between wind-energy development, local policies, and the emergence of local protests. The analysis confirms that the formation of local opposition emerges from a lack of local acceptance, beginning when the first WT plans become public. Moreover, a local conflict in the context of the formation of a CI can lead to a far-reaching division of society that can affect the political power relations of a municipality.

Weber et al. [56] investigate the structure, occurrence, and emergence of CIs as a reaction to wind-energy expansion in Germany. The methodological basis is discourse analysis and information on CIs, collected as part of Internet research, via Google, on citizens' response to national and regional plans. Key findings confirm the CIs' attempt to inhibit concrete planning projects in a closer spatial context. However, the goals of the CIs noticeably differ significantly and range from a complete and fundamental rejection of wind-energy expansion to a rejection of nearby individual projects. Argumentatively, 91% of the CIs base rejection on environmental parameters, 86% on the change in the landscape, and 83% on health aspects. Also, 69% of the arguments cited economic effects, such as the depreciation of real estate and the loss of tourist attractiveness. Overall, intricate and strongly mixed patterns of reasons that CIs establish and participate in protests are evident.

To sum up, procedural and economic participation by the local population is the strongest driver of increasing acceptance of WT. Furthermore, past personal experiences with WT are an important factor in individuals preventing a wrong risk assessment. On the contrary, environmental and economic aspects and a lack of local acceptance for planned projects at the local level, difficult to generalize, strongly influence the formation of CIs. Compared to the existing literature on the topic, the present study differs in its alternative methodological approach, made possible through a quantitatively and qualitatively greatly improved data basis. As shown above, most research depended on survey data and interviews. We seek to expand the knowledge about the formation of CIs in different spatial contexts and under different conditions for the development of WT installations, for Germany as a whole.

2. Empirical approach

2.1. 2.1 Data

Our study follows Guggenberger [57], defining CIs as associations of individual citizens who, for a specific reason (e.g., an expected wind farm), form a closed, formalized opposition to new wind farms, to exert political pressure. According to Weber et al. [58], a CI leads to an inhibiting influence on the planning process [59]. Consequently, planners categorize them as "problematic" [60]. Accordingly, CIs present as formalized expressions of protest toward WT development in Germany. Therefore, we collected data on CIs to define our dependent variable. That is, we seek to identify the contribution of several factors in the formation of CIs. On the other hand, we use the data on CIs to prove their effect on the installation of new WTs across a broad range of distances.

The protest platform Windwahn.com (as of June 2017) provided the initial CI information the researchers collected. In addition to names and contact details, the site contains a georeferenced description of each CI registered there [61]. Registrations must be actively initiated by an E-Mail from the CI to the platform operators. However, the degree to which the site checks the completeness and accuracy of the transmitted data is not transparent. We found that the raw data set contains numerous incomplete, duplicate, and visibly incorrect entries[4]. Consequently, we checked all entries for plausibility and adjusted the data when needed. While precise information about the representativeness or completeness of the listed protest farms does not exist, we learned from subsequent contacts with various CIs that this platform represents the most important one of its kind in Germany, and any serious CI would know about it and register there.

We collected additional features of the citizens' initiatives from this database. In a first step (October 2017), we contacted all CIs and asked for information on their organizational form (legal status, interest group, or other), their founding date, and other protest groups of which they are aware. We repeated this in January 2018. Unfortunately, we still managed to obtain responses from just 6.6% of the CIs. If the CI did not provide the required data, their information was supplemented through further investigations, including the use of official register entries[5], analyzed websites, official journal entries, and newspaper reports. In some cases, social media entries provided information about the founding date. Through this procedure, we determined the founding date, location, and organizational form for 817 CIs. We could acquire no information for 93 CIs, which we excluded. Possible reasons for this might include incorrect entries in the database or a lack of CI public-relations activities.

This information supported the construction of our central variable **FORMATION**. This binary variable takes the value of one if a CI is founded in a given year in a municipality, and zero otherwise. We specified three more variables on this basis (**INI.10**, **INI.25,** and **INI.50)**, representing the number of existing CIs in a given year within a 10/25/50-kilometer radius of the center of a municipality (centroid), respectively.

The second essential data set this study used contained information on WT. The locations of the WT came from the proven reliable [46, 65] secondary dataset of the German Society for Solar Energy e.V. [64], with data based on the freely available publication of the four transmission system operators in Germany. It is the only available dataset showing the actual location of (nearly) all WT in Germany. Due to political and legal conditions, this dataset's reliability sharply decreased after July 2014, as the system operators were no longer required to share their data. Therefore, this database includes only 25,138 of the currently (2019) 28,675 WT. Put differently, while the data is complete and reliable up to 2014, its completeness after 2014 is doubtful. Nevertheless, with no reason to believe that its incompleteness has any systematic spatial variance, we opted to include these years.

---

[4] During the cleanup process, we removed duplicate entries, empty columns, and obviously false information. CIs that could not be verified by a register and Internet search were retained.
[5] See [62] and [63]

On the basis of this dataset, we constructed the variables **WT.5**, **WT.10**, and **WT.25**, representing the number of existing WT in a particular year, within a 5/10/25-kilometer radius of the center of a municipality (centroid), respectively.

The first general regional characteristic that is likely to impact the construction of wind turbines, the emergence of CIs, and the relation between them is a region's (397 NUTS-3 regions) absolute population (**POPULATION**). The variable controls for regions' size variations. We used population density to distinguish between urban and rural regions (**POPULATION.DENSITY**).

Another factor we considered was a location's nearness to the coast, approximated by the shortest geographic distance to the coastline (North Sea and Baltic Sea) (**DISTANCE.COAST**). We used this variable because wind capacity is a crucial factor for the installation of WT. This capacity is significantly larger near the coast, making the installation of WT more likely [66].

In addition to the distance to the sea, we also considered the potential influence of protected areas in this context. As Nordman/Mutinda [67] suggest, WT developments near protected areas are more likely to mobilize resistance than the construction of WT in regions where agriculture or industry dominates. The variable **DISTANCE.PROTECT** measures the distance from the center of a municipality to the next protected area, in the sense of the Digital Landscape Model (DLM250) of the Federal Agency for Cartography and Geodesy [68]. Accordingly, environmental-, soil-, and water-protection areas are recorded according to uniform standards and considered in the investigation.

The fact that WT more strongly impact more attractive landscapes [69] may be an additional motivation for founding a CI. The variable **ATTRACTIVITY captures this,** representing an index of scenic attractiveness that the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) created [70]. It summarizes the following elements in a region: relief energy (measured by volatility of altitude), degree of forest cover, proportion of water surface, and length of coasts and uninterrupted spaces. We refrain from considering regions' tourism potential as an alternative measure because we believe that an unadulterated impression of the attractiveness of the landscape gives a more precise representation of this process.

The socio-economic structure of the population in a region and the potential commitment to climate may influence the likelihood of founding a CI [4, 19,], even if results are ambiguous [71, 72]. However, we considered different interests and population structures by constructing two variables: the proportion of over-65s (**AGE**) in the regional population and the proportion of voters who participated in the national elections (1994, 1998, 2002, 2005, 2009, 2013, 2017) and voted for the Green Party *Bündis90/DieGrünen* (**GREENS**). The selection of the latter variable was motivated by the significantly positive influence of the "green electorate" on the construction of WT [73].

Our study covers the period between 1990 and 2017. All information collected was at the municipality level, and we exclusively considered municipalities within a 50 km radius of a WT or that report a CI in the observation period. This translates into a total of 4,465 spatial units, including municipalities (*Gemeinden*) and municipal associations (*Gemeindeverbaende*). The latter are combinations of municipalities more comparable to the average municipality than their individual elements [74].

The variables differ significantly in their temporal dimension. For example, some variables are time-invariant (e.g., distance to shore), others vary annually (e.g., population), and others change only at certain time intervals (e.g., election results). While the former two cases can easily be integrated into our empirical modeling, an assumption must be made in the latter case: The election results are representative of the entire period of the legislature. Accordingly, the election results from the year t are also considered stable for the following years t + x.

2.2. Methods

The aim of the first investigation was the identification of regional factors that influence the probability of CIs forming. We paid particular attention to the existence of WT and their influence on the formation of CIs. Correspondingly, spatial-structural factors which emerged over time explained variations in the occurrence of the event (formation of an initiative) at a specific time (year) and in a specific place (municipality). In a common manner, we employed survival models (also known as event-history analysis) in this situation. Medical research initially developed survival models. The multivariate regression models relate the risk (hazard) of the occurrence of a particular event (e.g., infection/death) to explanatory variables, such as whether a patient has received medical treatment [75].

Nowadays, the models are used in many different fields of study. For example, Darmofal [76] investigates the spread of political ideas in the US using survival models. Studies in the economics literature frequently employ them to investigate company entries [77].

Basically, a survival model has the following form:

$$p_{(t)} = p_0(t) \exp(\beta^T x(t)),$$

where $p_{(t)}$ represents the probability of event occurrence at time t (e.g., the formation of an initiative); $p_0(t)$ is the underlying probability of entry, e.g., the probability of occurrence regardless of the characteristics of the explanatory factors; $x(t)$ represents the vector of explanatory variables that are likely to affect the event occurrence potential; β^T are the coefficients found in the model [78]. The reason for using survival models instead of OLS or binary logistic regressions is the special form of *censoring* inherent in these longitudinal data. In this context, *censoring* means that certain events are outside the period of observation. For example, during the observed period, we do not see any initiative being formed in a particular region, but this may happen in the (unobserved) future. Considering this in survival models accordingly avoids distortion of the calculations [79]. We use a so-called Cox model, which does not require assumptions of the probability of the event occurrence [80], reducing the likelihood of misspecification. However, it also implies a loss of precision that is higher in alternative Weibull or Gompertz models (if correctly specified) [76, 81].

The spatial structure of our data demands taking potential spatial dependencies into account, e.g., by estimating a Bayesian spatial survival model [82]. However, the implementation of these models in existing software programs still has great shortcomings. Therefore, we defer to a mixed-effects Cox regression model. This extension of Cox regression allows the modeling of random (intercept) effects that catches potential differences between particular groups of observations [83]. In the present case, the groups are districts (NUTS3 regions with, on average, about 30 municipalities). Accordingly, we take spatial dependencies between municipalities belonging to the same district into account. In addition to federal states, districts are the main administrative units in Germany, with significant power in terms of regional planning and policy. Consequently, most (potential) spatial dependencies that stem from these factors are considered. The modeling of WT in municipality neighborhoods (i.e., at 5, 10, and 25 km radii), as well as such time-invariant factors as distances to the coastline, absorb additional potential spatial dependencies.

The coefficients of the models are logarithmic hazard ratios, converted into hazard ratios for easier interpretation. Accordingly, they indicate the percentage by which the likelihood of occurrence (for example, the formation of a citizens' initiative) increases when the explanatory factor (e.g., the number of WT) increases by one unit. Coefficients smaller than one result in a reduction of the hazard, so formation of a CI or erections of WT, respectively, are less likely.

In the first sets of models (Table 1), we explain the likelihood of the formation of a CI at a given time in a municipality. Of the 817 identified CIs, 617 founding events fall during the considered period. They are evaluated against 121,869 zero events (no formation of a CI in a municipality in the year).

In the second set of models (Table 2), the aim is to analyze the impact of the CIs on the installation of WT. Again, we use the same modeling approach. In contrast to the first analysis, here the event to be explained (or the probability of its occurrence) is the construction of the next WT, to be installed after the formation of a CI.

In all estimations, we differentiate between the three categories of distances of CI and WT (5, 10, 25 km), which we examine in separate models. Thereby, we take into account the different sizes of municipalities and the fact that there are no findings concerning the scope of action of CIs. In the empirical exercise, we use the variables **WT.5**, **WT.10,** and **WT.25,** defined above. These are binarized so that they take a value of one if the number of WT in the area has increased compared to the previous year and zero if it has remained constant.

We adjusted the dataset (municipalities*years) for each model so that only observations for which these events can actually occur remain in the model. That is, we exclusively consider the period between the formation of an initiative and the first subsequent change in the number of WT in the respective vicinity of a municipality. We seek to explain the time it takes until (if ever) a WT is installed in a region after an initiative has been founded. Any changes in the number of WT subsequent to this event after the formation of the CI are not considered in the estimations. For the models in which the period up to the next WT within 5 km (**WT.5**) is analyzed after the formation of an initiative, we have 2,487 positive events (an increase in the number of WT in regions without CI in all years before) and 103,557 null events. The corresponding figures for models **WT.10** and **WT.25** are 4,953 and 85,113, and 11,483 and 52,966, respectively.

3. Results

Figure 1 illustrates the evolution of the CIs and WT. The figure contains four snapshots of the situation until the year 2000 (panel 1, top left), and for the periods 2000 to 2006 (panel 2, top right), 2006 to 2012 (panel 3, bottom left), and for 2012 to 2017 (panel 4, bottom right). To create a clear representation, WT within a radius of 10 kilometers and CIs within a radius of 5 kilometers were aggregated.

Panel 1 in Figure 1 confirms the emergence of the wind turbine installation in the windy coastal zones of the German North and Baltic Sea shorelines. The visualization also highlights that up to the turn of the millennium, just about 5,460 WT were operated in the country, with most located in the Rhenish Slate Mountains and the Ore Mountains. At the same time, 18 CIs existed, mostly in the northern part of Germany. In the subsequent period (2000–2006, panel 2 in Figure 1), the number of WT increased substantially to 15,162. In addition to the expansion of areas already utilized in the northwest and the North German Plain, in this period WT are installed in the southwest as well (Rhineland-Palatinate, Baden-Wuerttemberg, and Bavaria). Compared to the previous developments, a moderate increase in CIs (63) appears again, with a concentration in northern Germany. Panel 3 (2006–2012) shows further robust growth in WT (20,617) over the entire federal territory, except the two southernmost states of Baden-Württemberg and Bavaria. In this period, an active formation of CIs (184) is visible, especially in the north (Schleswig-Holstein), in the east (Brandenburg and Saxony), and the west (North Rhine-Westphalia, Hesse, and Rhineland-Palatinate). In the period represented by Panel 4 (2012–), further growth in WT appears, culminating at 25,106. During this time, the formation of CI (783) increased sharply. Especially at the former pioneer sites in Schleswig-Holstein, but also along the axis from the Saarland to Saxony and in the northern Hessian highlands, new CIs formed in the past six years. Another striking feature is the formation of CIs in locations without new WT, e.g., in southern Hesse and Baden-Württemberg.

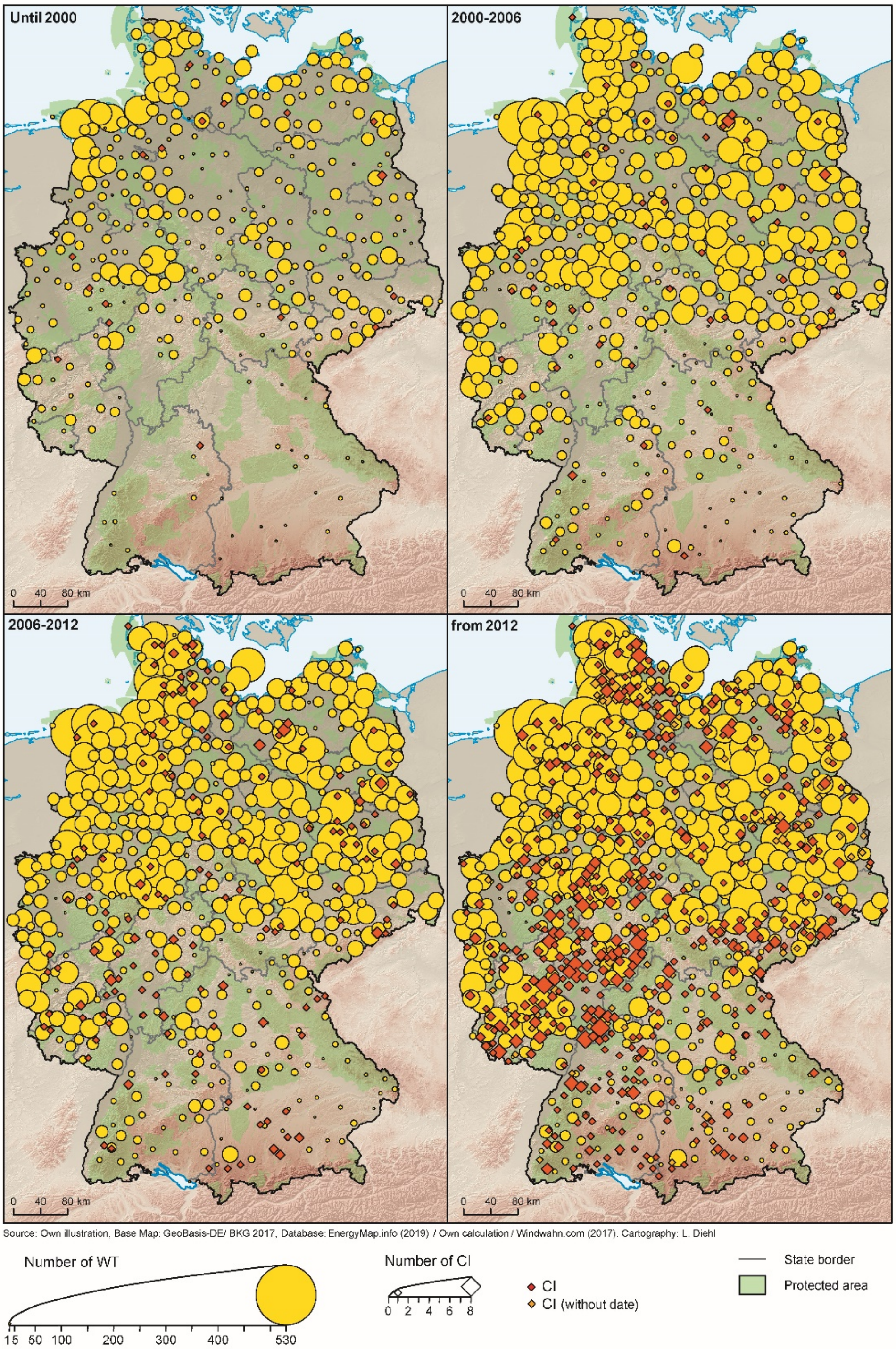

Figure 1: Spatiotemporal development of WT and CI in Germany from 1997 to 2017 Source: Own calculation

The heterogeneous dynamics give rise to some interesting observations. Existing research generally argues that traditional wind-energy sites are associated with higher acceptance rates (e.g., [14]). This does not seem to correspond to our findings, using CIs as indications of opposition. Even in parts of Germany with wind-energy usage already established, new protest movements have arisen. A potential explanation for this is that inhabitants of these regions are aware of the (uneven) spatial distribution of wind-power generation and are asking themselves the question of the procedural justice of this uneven distribution of WT [2, 41, 42, 84]. Furthermore, additional WT may be rejected when the local population can accept a certain number of WTs, and any additional developments will lead to opposition and the formation of CIs. The multivariate survival analyses, whose results appear in Tables 1 and 2, deepen the insights of the visual inspections. Table 1 shows the results for the dependent variables being the construction of new WT within 5, 10, and 25 kilometers of a focal municipality. Table 2 includes the regression results for the emergence of new CIs, whereby the models differ in the considered distances between WT and CI.

The coefficients presented in Table 1 show the relationship between spatial factors and the emergence of CIs. The significantly negative coefficient of DISTANCE.COAST confirms our expectations and the above visual inspections: With increasing distance to the coast, fewer WT are built. The same relationship applies to increasing population density (POPULATION.DENSITY). The more sparsely populated areas are the more likely sites for wind-turbine construction, highlighting the availability of land as a crucial constraint on WT. On the other hand, total population has a positive relationship with new WT construction. Surprising at first glance, this result has a plausible explanation. When controlling for population density, absolute population primarily captures the size of regions, and larger regions offer more opportunities for WT construction. In line with our expectations across all models, scenic attractiveness has a significantly negative relationship with the construction of new WT.

	Dependent variable:					
	NEW WT 5 KM	NEW WT 5 KM	NEW WT 10 KM	NEW WT 10 KM	NEW WT 25 KM	NEW WT 25 KM
	(1)	(2)	(3)	(4)	(5)	(6)
POPULATION	1.016***	1.016***	1.009***	1.009***	1.003	1.003
	(1.003)	(1.003)	(1.003)	(1.003)	(1.003)	(1.003)
DISTANCE.COAST	0.996***	0.996***	0.996***	0.996***	0.995***	0.995***
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
DISTANCE.PROTECT	1.015***	1.015***	1.016***	1.016***	1.010***	1.010***
	(1.005)	(1.005)	(1.004)	(1.004)	(1.003)	(1.003)
ATTRACTIVITY	0.999***	0.999***	0.999***	0.999***	0.999***	0.999***
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
AGE	0.999***	0.999***	0.999***	0.999***	1.000*	1.000*
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
POPULATION.DENSITY	1.000***	1.000***	1.000***	1.000***	1.000**	1.000**
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
GREENS	1.014	1.014	0.989	0.988	0.997	0.997
	(1.016)	(1.016)	(1.013)	(1.013)	(1.010)	(1.010)
EXISTING.WT.5	1.040***	1.040***				
	(1.002)	(1.002)				
FORMATION		0.886		0.834*		0.941
		(1.172)		(1.111)		(1.060)
EXISTING.WT.10			1.019***	1.019***		
			(1.001)	(1.001)		
EXISTING.WT.25					1.000	1.000
					(1.000)	(1.000)
Random intercept KGS	Yes	Yes	Yes	Yes	Yes	Yes
Events	2483	2483	4934	4934	11450	11450
Observations	103,557	103,557	85,113	85,113	52,966	52,966
R^2	0.022	0.022	0.044	0.044	0.125	0.125
Max. Possible R^2	0.325	0.325	0.604	0.604	0.957	0.957
Log Likelihood	-19,253.460	-19,253.460	-37,556.320	-37,556.190	-79,530.060	-79,530.000
Wald Test	3,777.830***	3,777.760***	5,482.820***	5,485.530***	7,265.650***	7,265.400***
	(df = 8)	(df = 9)	(df = 8)	(df = 9)	(df = 8)	(df = 9)
LR Test	2,258.253***	2,258.253***	3,806.898***	3,807.143***	7,050.425***	7,050.553***
	(df = 8)	(df = 9)	(df = 8)	(df = 9)	(df = 8)	(df = 9)
Score (Logrank) Test	9,766.544***	9,780.272***	10,004.060***	10,024.320***	8,485.896***	8,487.273***
	(df = 8)	(df = 9)	(df = 8)	(df = 9)	(df = 8)	(df = 9)
Note:						*p<0.1; **p<0.05; ***p<0.01

Table 1: Influence of CIs and spatial structural factors on the WT construction Source: Own calculations

In some contrast to our expectations is the significantly positive coefficient of distance to protected areas (DISTANCE.PROTECT). We believe that this counterintuitive finding is due to increasing proportions of protected areas being located in more rural and agricultural areas, which also represent more suitable areas for WT. We identified no effect between the construction of new WT and the share of voters for the party Bündnis90/DieGrünen (GREENS) in the models. In this case, our study contrasts with previous research by Goetzke/Rave [73], who identify a weakly positive influence of this party electorate on wind-energy expansion. In contrast, our results most likely reflect that this party is particularly strong in urban regions, which are less prone to new WT construction. Consequently, the observed coefficient points in the opposite direction. The use of municipal election results, in contrast to the results of the federal election employed in the present study, might have led to other findings. Lacking nationwide data on local elections for the period under consideration, we must leave this to future research. Nevertheless, in sum, our models do reflect most of the expected relations between spatial factors and the construction of wind turbines, giving us confidence in their results with respect to the variables in the focus of the present study.

However, contrasting with our expectations is the inability to identify an effect of CIs on the establishment of additional wind turbines for all ranges (FORMATION). The corresponding coefficient remains insignificant for the models of 5km and 25km, suggesting that regions in which CIs exist at a certain moment in time have the same likelihood of seeing a new WT established in subsequent years as regions without these initiatives for the short and the long terms. The effects of these initiatives seem rather limited for this scope, but for the 10km range, the formation of CIs can significantly disturb the installation of new WT. This finding proves that the efficiency range of CIs is more local than regional.

Now, we turn to the models relating spatial factors to the formation of anti-wind-turbine initiatives. Generally, we find the coefficients of the spatial-structural factors similar to the previous investigation, further strengthening the idea of relatively close co-development (compare Tables 2 and 1).

The first observation is that of a strong dynamic between the formation of new initiatives and the existence of wind turbines within 5 km (WT.5 in model 2) and within 10 km (WT.10 in model 4), with the effect appearing most pronounced in the latter case. With further increasing distance (WT.25 in model 6, with a 25 km radius), the effect loses strength and significance but remains negative. Consequently, additional WT within a distance of 10 km increase the likelihood that an anti-wind-turbine initiative will form sooner. In light of the insignificance of WT.25 and WT.50, this result suggests that initiatives are really a local reaction to increases in the number of wind turbines close by, i.e. within a rather small geographic distance.

	Dependent variable:					
	FORMATION (1)	FORMATION (2)	FORMATION (3)	FORMATION (4)	FORMATION (5)	FORMATION (6)
POPULATION	1.021***	1.021***	1.021***	1.021***	1.021***	1.021***
	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)	(0.004)
DISTANCE.COAST	0.998***	0.998***	0.998***	0.998***	0.998***	0.998***
	(0.0003)	(0.0003)	(0.0004)	(0.0003)	(0.0004)	(0.0004)
DISTANCE.PROTECT	0.978**	0.983*	0.976**	0.981*	0.978**	0.977**
	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)	(0.011)
ATTRACTIVITY	0.999***	0.999**	0.999***	0.999**	0.999***	0.999**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
POPULATION.DENSITY	0.999***	0.999***	0.999***	0.999***	0.999***	0.999***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
AGE	1.001**	1.001***	1.001**	1.001***	1.001**	1.001**
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
GREENS	1.102***	1.088***	1.102***	1.089***	1.101***	1.102***
	(0.022)	(0.020)	(0.022)	(0.020)	(0.022)	(0.022)
INI.50		1.082***		1.084***		
		(0.009)		(0.009)		
EXISTING.WT.10			1.005**	1.006***		
			(0.002)	(0.002)		
INI.10					1.317***	1.325***
					(0.088)	(0.088)
EXISTING.WT.50					1.000	
					(0.0003)	
EXISTING.WT.25						1.001
						(0.001)
Random intercept KGS	Yes	Yes	Yes	Yes	Yes	Yes
Events	617	617	617	617	617	617
Observations	121,869	121,869	121,869	121,869	121,869	121,869
R^2	0.001	0.002	0.001	0.003	0.002	0.002
Max. Possible R^2	0.081	0.081	0.081	0.081	0.081	0.081
Log Likelihood	-5,051.462	-4,990.517	-5,049.553	-4,986.435	-5,034.972	-5,034.427
Wald Test	185.080***	308.940***	188.840***	316.790***	220.170***	220.850***
	(df = 7)	(df = 8)	(df = 8)	(df = 9)	(df = 9)	(df = 9)
LR Test	177.581***	299.471***	181.399***	307.636***	210.561***	211.651***
	(df = 7)	(df = 8)	(df = 8)	(df = 9)	(df = 9)	(df = 9)
Score (Logrank) Test	190.807***	334.147***	195.622***	343.944***	229.781***	230.909***
	(df = 7)	(df = 8)	(df = 8)	(df = 9)	(df = 9)	(df = 9)
Note:						*p<0.1; **p<0.05; ***p<0.01

Table 2: Results of the survival analysis for the formation of CIs Source: Own calculations

In all models, we find the likelihood of a CI formation dwindling as the distance to the coast (DIST.COAST), and the attractiveness of the landscape increases (ATTRACTIVENESS), as well as when population density grows (POPULATION.DENSITY). These findings reflect two things. First, there are fewer WT away from the coast, around metropolitan and naturally more attractive areas because of stronger competition with other uses of these areas. Second, the findings are likely to reflect a greater willingness to keep areas near settlements and close to protected and attractive areas free from WT. Fitting the observation that an older population [85] forms and supports many protest initiatives, the average age of regional populations is significantly positive (AGE).

In contrast, we find larger populations increasing the likelihood of initiative formation, a consequence of the potentially greater need (larger area of region) or a larger pool of potential protesters. In addition, larger population supports the emergence and fueling of the complex motivational process behind the formation and keeping up protest-group processes [86].

In contrast to the relationship between the Greens and WT installation, all models show a robust and highly significant relationship of the variable **GREENS** on the formation of CIs. One explanation for this is that the increasing political influence of an environmentalist, i.e., a pro-wind party, promotes more WT, which translates into higher conflict potential. However, this claim has little empirical support [73]. Alternatively, it may also indicate the presence of more people inclined to protest through the formation of a political initiative that (may) contradict their convictions. Reusswig [85] locates this effect, particularly in structurally weak regions with high numbers of WT, where the population less opposes wind turbines as such than their perceived treatment in top-down planning processes[6]. Warren et al. [**87**] offer a further explanation for this effect, where green supporters oppose wind turbines, due to the impacts on wildlife and protected landscapes, and have substantially more resources (time, money) to professionalize their agenda.

With respect to our focal variables, we find empirical support for neighborhood or spillover effects of CIs. The relevant variables (INI.10 and INI.50) are significantly positive in all models. This means that existing nearby CIs have a positive impact on the formation of new citizens' initiatives. This was investigated in models (2) and (4) for the existence of initiatives within a radius of 50 km, and in models (5) and (6) for a radius of 10 km. The more significant coefficients in the latter specifications support the conclusion that an existing CI in an immediate vicinity encourages the formation of new CIs. Looking at Figure 1 and keeping the negative coefficient of DISTANCE.COAST in mind, this proximity effect is likely the explanation for the agglomeration of CIs in the inland of Germany. Moreover, this is consistent with

---

[6] In structurally strong regions with small numbers of wind turbines, "self-confident protests of local elites" are expected to represent the same initial situation [85].

the observed professionalization of CIs and their merging into umbrella organizations at the federal and national levels in recent years. With respect to anti-wind-turbine initiatives, only a case study has previously shown this idea of spatial spillover and neighborhood effects [4]. Our results suggest that this is a more general process influencing the formation of these initiatives in Germany, as a whole.

4. Conclusion

This study fills a gap in the existing literature on the relationship between the formation of anti-wind-turbine citizen initiatives and wind turbines. Utilizing a new dataset, the study provides a comprehensive spatiotemporal analysis of the formation and impact of CIs, previously done exclusively through qualitative studies (see, e.g., [4, 56]).

The study simultaneously analyzes the fundamental relationship of spatial and structural factors with the construction of WT and the formation of CIs against WT. It quantifies the field of tension between these two. In this way, the study results support the view that CIs emerge as a reaction to the construction of wind turbines. Moreover, we show that the existence of initiatives promotes the likelihood of further initiatives emerging in the immediate vicinity (~ 10 km) and that the effective range of initiatives to prevent the installation of WT is approximately 10km. Accordingly, personal contacts and social interactions, as well as supra-regional associations and networks, may drive the diffusion of this form of protest (see on this [4]). An alternative explanation appears in the peculiarity of WT as "locally unwanted land uses." It implies that growing protests are inevitable when the number of WT increases, regardless of how objectively meaningful they are [36]. Nevertheless, we must admit that our data is limiting our results to concrete assumptions on the formation of CIs. As we do not know anything about the size of CIs and planned but never built WTs, we cannot compare the different CIs, where they form, and how successfully they constitute a hindrance to WTs. Furthermore, in future research, the reliability of the dataset could improve with the addition of data for the WT installed after 2014.

However, for planning authorities and political decision-makers, some recommendations arise from our findings. In the context of siting and the subsequent approval procedures, our results suggest that care should be taken to ensure that in regions with active protest groups, early participation may be a key to successful acceptance. This also implies the provision and sharing of objective information.

On the whole, it is striking that the formation dynamics of CI have been steadily intensifying since 2006 throughout Germany, especially in areas with a strong WT presence. This polarization of the energy landscape in Germany is concomitant with the general dynamics of wind-energy expansion, which a negative attitude has increasingly confronted in recent years. Importantly, the present study does not allow identifying whether the emergence of a formalized protest movement arises from a (regionally) fundamental consensus around rejecting WT. Also, relatively small but highly motivated subgroups may have driven the formation of CIs. This must be investigated in more detail, using qualitative and/or more extensive quantitative research designs in local contexts. In particular, we advocate interdisciplinary approaches that more explicitly consider the socio-demographic structures within individual CIs [85].

While the present study provides new and generalizable insights into the relationship with the conditions of anti-wind-turbine protests, we recognize that this relationship is dynamic and deeply embedded in a constantly changing and evolving environment. Among other implications of the research are that the database underlying the present study is constantly updated and the addition of regional factors (e.g., local elections, land use, and educational level). Even more importantly, qualitative research should seek to know why CIs form at certain places, as well as how successfully they hinder the construction of new WT in their surroundings. In addition, future studies also must investigate the extent to which our results are restricted to Germany or if similar relationships are observed in other countries. Lastly, future analyses must clarify how regional planning approaches and urban land-use planning influence these processes [31, 88].

References

[1] Wiser, R., Z. Yang, M. Hand, O. Hohmeyer, D. Infield, P. H. Jensen, V. Nikolaev, M. O'Malley, G. Sinden, A. Zervos (2011): Wind Energy. In: IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[2] Bosch, S., & Schmidt, M. (2020). Ungerechte Energielandschaften–die Produktion von Raum im Kontext der Transformation des deutschen Energiesystems. Geographica Helvetica, 75(3), 235-251.

[3] Deutsche WindGuard (2019): Status des Windenergieausbaus an Land in Deutschland. Erstes Halbjahr 2019. Varel.

[4] Reusswig, F., Braun, F., Heger, I., Ludewig, T., Eichenhauer, E., Lass, W. (2016): Against the wind: Local opposition to the German Energiewende. In: Utilities Policy 41(2016), 214-227.

[5] Schultz, S. (2019): Die große Windkraftkrise. https://www.spiegel.de/wirtschaft/soziales/windenergie-die-grosse-windkraftkrise-a-1279820.html (accessed 23.01.2020)

[6] Walker, C., Baxter, J., & Ouellette, D. (2014): Beyond rhetoric to understanding determinants of wind turbine support and conflict in two Ontario, Canada communities. Environment and Planning A, 46(3), 730-745.

[7] Enevoldsen, P., Sovacool, B. K. (2016): Examining the social acceptance of wind energy: practical guidelines. In: Renewable and Sustainable Energy Reviews 53(2016), 178-184.

[8] Suškevičs, M., Eiter, S., Martinat, S., Stober, D., Vollmer, E., de Boer, C. L., & Buchecker, M. (2019). Regional variation in public acceptance of wind energy development in Europe: What are the roles of planning procedures and participation?. Land Use Policy, 81, 311-323.

[9] Thayer, R. L., Freeman, C. M. (1987): Public perceptions of a wind energy landscape. In: Landscape and Urban Planning 14(1987), 379-398.

[10] Wolsink, M. (1988): The social impact of a large wind turbine. In: Environmental Impact Assessment Review 8(1988), 323-335.

[11] Wolsink, M. (1989): Attitudes and expectancies about wind turbines and wind farms. In: Wind Energy 13(1989), 196-206.

[12] Walker, G. (1995): Renewable energy and the public. In: Land Use Policy 12(1995), 49-59.

[13] BWE (2021). Windenergie in Deutschland – Zahlen und Fakten. https://www.wind-energie.de/themen/zahlen-und-fakten/deutschland/ (accessed 23.05.2021)

[14] Wolsink, M. (2007a): Wind power implementation: The nature of public attitudes: Equity and fairness instead of "backyard motives". Renewable and Sustainable Energy Reviews 11(2007), 1188-1207.

[15] Bell, D., Gray, T., Hagget, T. (2005): The "social gap" in wind farm siting decisions: explanations and policy responses. In: Environmental Politics 14(2005), 460-477.

[16] Walter, G. (2014): Determining the local acceptance of wind energy project in Switzerland: The importance of general attitudes and project characteristics. In: Energy Research & Social Science 4 (2014), 78-88.

[17] Aitken, M. (2010): Why we still don't understand the social aspects of wind power: A critique of key assumptions within the literature. Energy Policy 38(2010), 1834-1841.

[18] Bell, D., Gray, T., Hagget, T., Swafford, J. (2013): Revisiting the "social gap": public opinion and relations of power in the local politics of wind energy. In: Environmental Politics 22(2013), 115-135.

[19] Devine-Wright, P. (2005): Beyond NIMBYism: towards an Integrated Framework for Understanding Public Perceptions of Wind Energy. In: Wind Energy (8), 125-139.

[20] Devine-Wright, P. (2009): Rethinking NIMBYism. J. Community Appl. Soc. Psychol. 19, 426-441.

[21] Devine-Wright, P. (2012): Explaining NIMBY objections to a power line: the role of personal, place attachment and project-related factors. Environ. Behav. 45, 761-781.

[22] Van der Horst, D. (2007): NIMBY or not? Exploring the relevance of location and the politics of voiced opinions in renewable energy siting controversies. In: Energy Policy 35(5), 2705-2714.

[23] Sovacool, B. K., Ratan, P. L. (2012): Conceptualizing the acceptance of wind and solar electricity. In: Renewable and Sustainable Energy Reviews 16(2012), 5268-5279.

[24] Jones, C. R., & Eiser, J. R. (2010): Understanding 'local' opposition to wind development in the UK: how big is a backyard? In: Energy Policy, 38(6), 3106-3117.

[25] Swofford, J., & Slattery, M. (2010): Public attitudes of wind energy in Texas: Local communities in close proximity to wind farms and their effect on decision-making. In: Energy policy, 38(5), 2508-2519.

[26] Wolsink, M. (2018): Social acceptance revisited: gaps, questionable trends, and an auspicious perspective. In: Energy research & Social Science 46(2018), 287-295.

[27] TNS Infratest (2012): Umfrage zur Akzeptanz des Erneuerbaren-Energien-Gesetzes, Bad Godesberg.

[28] TNS Emnid (2014): Umfrage zu erneuerbaren Energien im Auftrag der Agentur für erneuerbare Energien, Bielefeld.

[29] TNS Emnid (2015): Umfrage zu erneuerbaren Energien im Auftrag der Agentur für erneuerbare Energien, Bielefeld.

[30] Zoellner, J., Schweizer-Ries, P., Wemheuer, C. (2008): Public acceptance of renewable energies: Results from case studies in Germany. In: Energy Policy 36(2008), 4136-4141.

[31] Schweizer-Ries, P. (2010): Aktivität und Teilhabe – Akzeptanz Erneuerbarer Energien durch Beteiligung steigern. Projektabschlussbericht (FKZ 0325052).

[32] Permien, F.-H., Enevoldsen, P. (2019): Socio-technical constraints in German wind power planning: An example of the failed interdisciplinary challenge for academia. In: Energy Research & Social Science 55(2019), 122-133.

[33] Wüstenhagen, R., Wolsink, M., Bürer, M. J. (2007): Social acceptance of renewable energy innovation: An introduction to the concept. In: Energy Policy 35(2007), 2683-2691.

[34] Langer, K., Decker, T., Roosen, J., Menrad, K. (2016): A qualitative analysis to understand the acceptance of wind energy in Bavaria. Renewable and Sustainable Energy Reviews 64 (2016), 248-259.

[35] Jobert, A., Laborgne, P., Mimler, S. (2007): Local acceptance of wind energy: Factors of success identified in French and German case studies. In: Energy Policy 35(2007), 2751-2760.

[36] Selle, K. (2015): NIMBY, NIMFYE, LULU und andere… Vom Umgang mit Eigen-Sinn, oder: Gemeinwohl als Verfahren. Pnd-online 2015.

[37] Ishizaka, K., Tanaka, M. (2003): Resolving public conflict in site selection process – a risk communication approach. In: Waste Management 23(5), 385-396.

[38] Rogge E., Dessein, J., Gulinck, H. (2011): Stakeholders perception of attitudes towards major landscape changes held by the public: the case of greenhouse clusters in Flanders. In: Land Use Policy 28(1), 334-342.

[39] Popper, F.J. (1985): The environmentalist and the LULU. In: Environment 27(2), 6–11.

[40] Wolsink, M. (2007b): Planning of renewables schemes: Deliberative and fair decision-making on landscape issues instead of reproachful accusations of non-cooperation. In: Energy Policy 35 (2007), 2692-2704.

[41] Walker, C., & Baxter, J. (2017). Procedural justice in Canadian wind energy development: a comparison of community-based and technocratic siting processes. Energy research & social science, 29, 160-169.

[42] Simcock, N. (2016). Procedural justice and the implementation of community wind energy projects: A case study from South Yorkshire, UK. Land Use Policy, 59, 467-477.

[43] Kaya, I. A., Erol, N. K. (2016): Conflicts over Locally Unwanted Land Uses (LULUs): Reasons and solutions for case studies in Izmir (Turkey). In: Land Use Policy 58(2016), 83-94.

[44] Busse, M., Siebert, R. (2018): Acceptance studies in the field of land use – A critical and systematic review to advance the conceptualization of acceptance and acceptability. In: Land Use Policy 76(2018), 235-245.

[45] Wolsink, M. (2012): Wind Power: Basic Challenge Concerning Social Acceptance. In: Robert A. Meyers (ed.) Encyclopedia of Sustainability Science and Technology, 1785-1821.

[46] Broekel, T., Alfken, C. (2015): Gone with the wind? The impact of wind turbines on tourism demand. In: Energy Policy 86(2015), 506-519.

[47] Wang, S., & Wang, S. (2015). Impacts of wind energy on environment: A review. Renewable and Sustainable Energy Reviews, 49, 437-443.

[48] Musall, F. D., Kuik, O. (2011): Local acceptance of renewable energy – A case study from southeast Germany. In: Energy Policy 39(2011), 3252-3260.

[49] Warren, C., McFadyen, M. (2010): Does community ownership affect public attitudes to wind energy? A case study from south-west Scotland. In: Land Use Policy 27(2), 204-213.

[50] Cowell, R., Bristow, G., & Munday, M. (2011): Acceptance, acceptability and environmental justice: the role of community benefits in wind energy development. Journal of Environmental Planning and Management, 54(4), 539-557.

[51] Johansen, K., & Emborg, J. (2018). Wind farm acceptance for sale? Evidence from the Danish wind farm co-ownership scheme. Energy Policy, 117, 413-422.

[52] Süsser, D., Kannen, A. (2017): Renewables? Yes, please!: perceptions and assessment of community transition induced by renewable-energy projects in North Frisia. In: Sustainable Science 12(4), 563 – 578.

[53] Gross, C. (2007): Community perspectives of wind energy in Australia: The application of a justice and community fairness framework to increase social acceptance. In: Energy Policy 35(2007), 2727-2736.

[54] Walker, C., & Baxter, J. (2017): “It's easy to throw rocks at a corporation”: wind energy development and distributive justice in Canada. Journal of Environmental Policy & Planning, 19(6), 754-768.

[55] Frate, C. A., Brannstrom, C., de Morais, M. V. G., & de Azevedo Caldeira-Pires, A. (2019) : Procedural and distributive justice inform subjectivity regarding wind power: A case from Rio Grande do Norte, Brazil. Energy Policy, 132, 185-195.

[56] Weber, F., Jenal, C., Rossmeier, A., Kühne, O. (2017): Conflicts around Germany’s Energiewende: Discourse Patterns of Citizens‘ Initiatives. In: Quaestiones Geographicae 36(4), 117-130.

[57] Guggenberger, B. (2013): Bürgerinitiativen. In: Andersen, U., Woyke, W. (Hg.): Handwörterbuch des politischen Systems der Bundesrepublik Deutschland, 7. Auflage, Springer VS, Heidelberg.

[58] Weber, F., Kühne, O., Jenal, C., Aschenbrand, E., Artukovic, A. (Hrsg.) (2018): Sand im Getriebe. Aushandlungsprozesse um die Gewinnung mineralischer Rohstoffe aus konflikttheoretischer Perspektive nach Ralf Dahrendorf. Springer VS

[59] Gardt, M., Gareis, P. (2018): Mixed-Method-Analyse. Ein neuer methodischer Ansatz für die Analyse von Beteiligungsverfahren in der Regionalplanung. In: RaumPlanung 196/ 2/3-2018, 62-67.

[60] Smith Stegen, K., Seel, M. (2013): The winds of change: How wind firms assess Germany’s energy transition. In: Energy Policy 61(2013), 1481-1489.

[61] Windwahn.com (2017): Karte der Bürgerinitiativen, https://www.windwahn.com/karte-der-buergerinitiativen/ (accessed 05.06.2017).

[62] Handelsregister (2019): Gemeinsames Registerportal der Länder. https://www.handelsregister.de

[63] DENIC (2019): Deutsches Network Information Center. https://www.denic.de/webwhois/

[64] EnergyMap.info (2019). Entwicklung der WEA in Deutschland, http://www.energymap.info/download.html (05.09.2019)

[65] Gardt, M., Broekel, T., Gareis, P., Litmeyer, M.-L. (2018): Einfluss von Windenergieanlagen auf die Entwicklung des Tourismus in Hessen. In: Zeitschrift für Wirtschaftsgeographie 62(1), 46-64.

[66] Jung, C., Schindler, D. (2018): 3D statistical mapping of Germany's wind resource using WSWS. In: Energy Conversion and Management 159(2018), 96-108.

[67] Nordman, E., Mutinda, J. (2016): Biodiversity and wind energy in Kenya: revealing landscape and wind turbine perceptions in the world's wildlife capital. In: Energy Research & Social Science 19(2016), 108-118.

[68] Bundesamt für Kartographie und Geodäsie (BKG) (2018): DLM 250, http://www.geodatenzentrum.de/geodaten/gdz_rahmen.gdz_div?gdz_spr=deu&gdz_akt_zeile=5&gdz_anz_zeile=1&gdz_unt_zeile=1&gdz_user_id=0, (accessed 14.08.2019).

[69] Molnarova, K., Sklenicka, P., Stiborek, J., Svobodova, K., Salek, M., Brabec, E. (2012): Visual preferences for wind turbines: location, numbers and respondent characteristics. In: Applied Energy 92(2012), 269–278.

[70] Bundesamt für Bau-, Stadt- und Raumforschung (BBSR) (2008): Raumordnungsplanung und Kulturlandschaft. IzR 5.2008, https://www.bbsr.bund.de/BBSR/DE/Veroeffentlichungen/IzR/2008/5/GrafikenKarten.html?nn=422250#target8, (accessed 14.08.2019).

[71] Cloutier, G., Papin, M., & Bizier, C. (2018). Do-it-yourself (DIY) adaptation: Civic initiatives as drivers to address climate change at the urban scale. Cities, 74, 284-291.

[72] Thaler, T., & Seebauer, S. (2019). Bottom-up citizen initiatives in natural hazard management: Why they appear and what they can do?. Environmental Science & Policy, 94, 101-111.

[73] Goetzke, F., Rave, T. (2016): Exploring heterogeneous growth of wind energy across Germany. In: Utilities Policy 41(2016), 193-205.

[74] Bundesamt für Bau-, Stadt- und Raumforschung (BBSR) (2018): Erläuterungen zu den Raumbezügen, https://www.inkar.de/documents/Erlaeuterungen%20Raumbezuege.pdf, (accessed 14.08.2019).

[75] Fox, J., Weisberg, S. (2011): Cox Proportional-Hazards Regression for Survival Data in R. In An Appendix to An R Companion to Applied Regression, Second Edition.

[76] Darmofal, D. (2009). Bayesian spatial survival models for political event processes. American Journal of Political Science, 53(1), 241–257.

[77] Buenstorf, G. (2007): Evolution on the Shoulders of Giants: Entrepreneurship and Firm Survival in the German Laser Industry. Review of Industrial Organization, 30(3), 179–202.

[78] Perkins, R., Neumayer, E. (2005) The international diffusion of new technologies: a multitechnology analysis of latecomer advantage and global economic integration. Annals of the Association of American Geographers, 95 (4). pp. 789-808.

[79] Mills, M. (2011): Introducing Survival and Event History Analysis. SAGE Publications

[80] Cox, D. R. (1972): Regression Models and Life-Tables. In: Journal of the Royal Statistical Society B 34(2), 187 – 220.

[81] Box-Steffensmeier, J. M., Jones, B. S. (2004): Event History Modeling. A Guide for Social Scientists. Cambridge University Press.

[82] Zhou, H., Hanson, T. (2017): A Unified Framework for Fitting Bayesian Semiparametric Models to Arbitrarily Censored Survival Data, Including Spatially Referenced Data. In: Journal of the Americal Statistical Association 522(113), 571-581.

[83] Therneau, T., Grambsch, P., Pankratz V.S. (2003): Penalized survival models and frailty, J Computational and Graphical Statistics, 12:156-175.

[84] Liljenfeldt, J., Petterson, Ö. (2017): Distributional justice in Swedish wind power development – An odds ratio analysis of windmill localization and local residents' socio-economic. In: Energy Policy 105(2017), 648-657.

[85] Reusswig, F. (2016): Energiekonflikte – Akzeptanzkriterien und Gerechtigkeitsvorstellungen in der Energiewende. Darmstadt

[86] Kim, J. (2018): Why do people take to the streets? Understanding the multidimensional motivations of protesting publics. In: Public Relations Review 44(4), 501-513.

[87] Warren, C. R., Lumsden, C., O'Dowd, S., & Birnie, R. V. (2005): 'Green on green': public perceptions of wind power in Scotland and Ireland. Journal of environmental planning and management, 48(6), 853-875.

[88] Wirth, P., Leibenath, M. (2016): Die Rolle der Regionalplanung im Umgang mit Windenergiekonflikten in Deutschland und Perspektiven für die raumbezogene Forschung. In: Raumforschung Raumordnung 75(2017), 389-398.