Wind Energ. Sci., 7, 1679–1691, 2022
https://doi.org/10.5194/wes-7-1679-2022

eawe european academy of wind energy
Open Access WIND ENERGY SCIENCE

Public acceptance of wind energy – concepts, empirical drivers and some open questions

Michael Ruddat

ZIRIUS – Research Center for Interdisciplinary Risk and Innovation Studies,
University of Stuttgart, Seidenstr. 36, 70174 Stuttgart, Germany

Correspondence: Michael Ruddat (michael.ruddat@zirius.uni-stuttgart.de)

Received: 13 October 2021 – Discussion started: 27 January 2022
Revised: 30 March 2022 – Accepted: 25 July 2022 – Published: 11 August 2022

Abstract. The further development of wind energy is of major importance for the success of the energy system transformation in Germany and elsewhere. This transition process is not an easy task. For example, the yearly installed capacity of wind energy onshore in Germany has been declining since 2017. Only relatively few new wind turbines were constructed especially in 2019. Problems are, for example, minimum distance requirements (e.g. residential areas, air safety), the high complexity of planning processes and local protests. Social science research has now dealt with the topic of public wind energy acceptance for quite some time. On the one hand, the specific kind of acceptance (e.g. local acceptance) has been subject to scientific discourse. On the other hand, different empirical drivers (e.g. perceived distributional or procedural fairness, trust in relevant actors of the transformation process, risk–benefit perceptions, participation) have been of special interest. This review deals with central definitions and concepts, as well as qualitative and quantitative empirical findings, of social science research concerning the acceptance of wind energy in Germany and elsewhere. Although there has been already a lot of valuable scientific work done, there are still some open questions left.

1 Introduction

From a technical and economic perspective, the further development of wind energy is of major importance for the success of the energy system transformation in Germany and elsewhere. Wind energy is technically more advanced than most other renewable technologies, is economically profitable (i.e. relatively cheap) and can be relatively easily exploited (Cohen et al., 2014; Devine-Wright, 2005; Ellis and Ferraro, 2016; Hagett, 2011; Rand and Hoen, 2017). This transition process is not an easy task. The yearly installed capacity of wind energy onshore in Germany has been declining since 2017. Only relatively few new wind turbines were constructed especially in 2019. Problems are, for example, minimum distance requirements (e.g. residential areas, air safety), the high complexity of planning processes and local protests (AEE, 2020; Di Nucci et al., 2020). In Great Britain, a change in the planning law to allow for local control, together with the removal of financial support for onshore wind energy, has led to a dramatic decline since 2015 (Harper et al., 2019). In 2001, the biggest wind energy project in the Netherlands failed because the government refused to negotiate with environmental groups (Wolsink, 2007a). According to Hoen and colleagues, wind parks in the USA are moving closer to residential areas, raising the risk of conflict (Hoen et al., 2019). All in all, acceptance of wind energy projects seems to be relevant for the successful transformation of the energy system (Breukers and Wolsink, 2007; Cohen et al., 2014; Haggett, 2011; Harper et al., 2019; Rand and Hoen, 2017).

Social science research has now dealt with the topic of wind energy acceptance for quite some time (see, for example, Aitken, 2010a; Breukers and Wolsink, 2007; Devine-Wright, 2007; Hoen et al., 2019; Jones and Eiser, 2010; Krohn and Damborg, 1999; Pasqualetti, 2001; Sonnberger and Ruddat, 2017). On the one hand, the specific kind of acceptance (e.g. socio-political acceptance, market acceptance or community acceptance; Wüstenhagen et al., 2007) has been subject to scientific discourse. On the other hand, different empirical drivers (e.g. perceived distributional or procedural fairness, trust in relevant actors of the transformation process, risk–benefit perceptions, participation) have been of special interest. This review[1] deals with central concepts and definitions of acceptance, as well as qualitative and quantitative empirical findings of social science research concerning the public acceptance of wind energy in Germany and elsewhere. Although there has been already a lot of valuable scientific work done, there are still some open questions left.

2 Concepts and definitions of acceptance and research results

The iridescent concept of (risk) acceptance has already been defined and conceptualized by many scholars in social sciences (e.g. Cohen et al., 2014; Hübner and Hahn, 2013; Renn, 2008; Schweizer-Ries, 2008; Sauter and Watson, 2007; Upham et al., 2015; Wüstenhagen et al., 2007). Here are some examples that partially guided my own definition for this review:

- From an analytical point of view, acceptance can be understood as the balancing of pros and cons (benefit and risks) with a final decision to support or oppose an action, project or technology (Ajzen and Fishbein, 1980; Ajzen, 1991; Fischhoff et al., 1981; Groth and Vogt, 2014; Renn, 1984). This process can be related to positive or negative attitudes[2] (Cohen et al., 2014; Schäfer and Keppler, 2013), as well as behavioural intentions and behaviour itself (Petermann and Scherz, 2005).

- Another thought of school emphasizes the importance of emotions, feelings and moods for the judgement of the acceptability of risks (Böhm and Tanner, 2019; Klinke and Renn, 2002; Schwarz, 2002; Slovic et al., 2004). One example is the affect heuristic implying a reversed relationship between emotions and risk–benefit perceptions: positive emotions correlate with high benefit and low risk, whereas negative emotions are associated with low benefit and high risk (Böhm and Tanner, 2019). Accordingly, positive emotions can be connected to positive attitudes and vice versa.

- The connection between acceptance, attitudes and action is demonstrated by Upham and colleagues who define acceptance as "[...] a favourable or positive response (including attitude, intention, behaviour and – where appropriate – use) relating to a proposed or in situ technology or socio-technical system, by members of a given social unit (country or region, community or town and household, organization)" (Upham et al., 2015, p. 103). Schweizer-Ries and colleagues (e.g. Schweizer-Ries, 2008; Hildebrand et al., 2017) also make the link between attitude and (possible) action[3] and come up with a rather complex acceptance typology including supporters (positive attitude/intention or action), advocates (positive attitude/no intention or action), opponents (negative attitude/no intention or action) and protesters (negative attitude/intention or action).

- A very prominent concept is the one of Wüstenhagen et al. (2007). They differentiate between socio-political acceptance, market acceptance and community acceptance (sometimes also called "local acceptance"). *Socio-political acceptance* is located on the level of society and refers to technologies like wind energy and political programmes promoting these technologies. Relevant actors are the public, central stakeholders and politicians. *Market acceptance* means the purchase and use of goods and services in free markets. It focuses on products like roof-top solar collectors or services like green energy. Corresponding actors include consumers, investors and companies. *Community acceptance* refers to technological projects like wind farms in the vicinity of residential areas. Relevant actors are local residents, stakeholders and authorities (Wüstenhagen et al., 2007).

This review mainly deals with public and local acceptance of wind energy, wind turbines and wind parks. Accordingly, acceptance means a positive evaluation of a topic (like wind energy, wind turbines or wind parks) by individuals under certain circumstances (e.g. cultural or institutional context) that can have consequences for individual behaviour. Correspondingly, non-acceptance means a negative evaluation of a topic by individuals under certain circumstances that can have consequences for individual behaviour. If there is no clear positive or negative attitude towards the topic (e.g. ambivalence, non-attitude), we speak of tolerance that can have consequences for individual behaviour (but perhaps not so much as the endpoints of the continuum). It is important to

[1] This review does not claim to be exhaustive. The focus is on social science research concerning the perception and evaluation of wind energy (wind turbines as well as wind farms) by the public or parts of it (e.g. residents, stakeholders). In this sense it is a *stated or expressed preferences approach*. Studies using a *revealed preferences approach* by referring to realized and abandoned sites and how they relate to different independent variables are not considered here (see for the differentiation between stated/expressed and revealed preference Liebe, 2007; Slovic, 1987; Starr, 1969). The focus is also on *main* empirical drivers as frequently reported in social science research about the acceptance of wind energy. Some other aspects (e.g. socio-demographic variables, knowledge, environmental concern) may also be partly of relevance but are not considered here.

[2] Attitudes can be defined as "[...] a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour" (Eagly and Chaiken, 1993, p. 1).

[3] Similar definitions can be found in Hübner and Hahn (2013, p. 2), Perlaviciute and Steg (2014, p. 362), Sauer et al. (2005, p. I-1), and Sauter and Watson (2007, p. 2772).

say that this is a narrow definition, and acceptance is surely more complex than that (Ellis and Ferraro, 2016). For example, aspects like the financial system, support programmes, local context or planning legislation may play a role in acceptance. Additionally, acceptance is dynamic and may change over time. Unfortunately, considering all of these elements in detail would go beyond the scope of this article, as well as the data used here. Instead, I will deal with this point in the discussion section.

Despite the varying concepts and measurements, results are surprisingly often similar. For example, the acceptance typology of Schweizer-Ries and colleagues (Schweizer-Ries, 2008; Hildebrand et al., 2017) has been empirically applied on the basis of data coming from a representative telephone survey of the German population in 2015 ($n = 2006$). The survey focused on the perception and evaluation of renewables, especially the local acceptance. This local acceptance of wind parks, solar farms and high-tension power lines was operationalized by a 500 m distance to the respondent's place of residence. Results show high acceptance rates for solar farms, as well as a considerable potential for protest and opposition against wind farms and high-tension power lines (Ruddat and Sonnberger, 2019). This finding was successfully replicated by Liebe and Dobers (2019). They use a non-representative sample from a German panel to conduct an online survey in 2013 ($n = 3192$). The two researchers analyse acceptance of and potential protest against the construction of diverse renewable power plants (wind/solar/biomass) and a natural gas-fired plant within a 10 km radius of the respondent's place of residence. Irrespective of the different distances, survey methodology and operationalization, the acceptance ranking for solar energy (first place) and wind energy (second place) was the same as reported by Ruddat and Sonnberger (2019). The third place goes to biomass energy followed by natural gas in fourth place. The ranking for potential protest is just reversed (Liebe and Dobers, 2019).

While public survey research often reports high general support for wind energy in different countries (i.e. public acceptance, see, for example, Devine-Wright, 2005, 2007; FA Wind, 2020; Krohn and Damborg, 1999; Steentjes et al., 2017), there are low success rates in the implementation of it (e.g. AEE, 2020; Harper et al., 2019). This finding is called the "social gap" (Bell et al., 2005)[4]. There is also a remarkable difference between general and local support. Data from the Special Eurobarometer 364 show an all in all high public acceptance of wind energy in 12 different European countries ($n = 13091$; European Commission, 2011, p. 161). The same is all in all true for public acceptance of offshore and onshore wind energy, as can be seen in data from a representative cross-national survey in Germany, France, Norway and the UK. Only solar energy is rated better, and there is a clear preference for wind energy in comparison to oil, coal and nuclear power ($n = 4048$; Steentjes et al., 2017, p. 27). In contrast to this, local acceptance is more problematic. For example, researchers in Germany asked for the acceptance of solar farms, wind farms and high-tension power lines at 500 m distance to the respondents' home (representative telephone survey, $n = 2006$). While more than half of the respondents would have no problems with solar parks in their neighbourhood, only 35 % would be willing to accept a wind park in their vicinity. High-tension power lines are perceived as even more negative (Sonnberger and Ruddat, 2016, p. 36).

[4]There are several explanations for the social gap that will be taken up in the next section.

3 Empirical drivers of public and local acceptance of wind energy, wind turbines and wind parks

Social science research has identified several empirical drivers of wind energy acceptance. This review concentrates on prominent quantitative as well as qualitative studies from, for example, Australia, Great Britain, Germany, the Netherlands, Scotland, Sweden, Switzerland and the USA in the last decades. Although it is a relevant sample, it does not, of course, claim to be complete.

3.1 Visual effects and place attachment

Wind turbines as well as wind farms can be designed in different ways. For example, Pasqualetti compares the differences between wind parks in the USA and Europe with respect to colour, uniformity of heights, etc. He concludes that the European design with an all in all better compatibility with existing landscape seems to be far more acceptable for residents (Pasqualetti, 2001[5]). This means that wind turbines can have negative as well as positive visual effects (Hoen et al., 2019; Krohn and Damborg, 1999). They are not generally perceived of as ugly, and they can also symbolize progress (survey data from UK, $n = 1286$; Devine-Wright, 2005, pp. 128f; see also Swofford and Slattery, 2010; van der Horst and Toke, 2010). But irrespective of how well they are designed, they are not invisible (Pasqualetti, 2001).

These *visual effects* are often seen as a very important factor for public as well as local acceptance of wind energy (Breukers and Wolsink, 2007; Devine-Wright, 2005; Haggett, 2011; Jones and Eiser, 2010; Wolsink, 2007b). Wolsink states that "[...] visual evaluation of the impact of wind power on the values of the landscape is by far the dominant factor in explaining why some are opposed to wind power implementation and why others support it" (Wolsink, 2007b, p. 1194). Citing a study with residents near wind turbines in Sweden ($n = 351$; Pedersen and Persson Waye,

[5]It is important to say that the paper of Pasqualletti is a little bit more subjective than the other research cited in this review. Indeed, it is a more qualitative description of the situation back in 2001 and explicitly marked as an essay. But I found it to be very enriching especially because of the detailed descriptions in it (and he gives good reasons for his opinion). In addition, the results do not contradict other research results but rather complement them.

2004) he comes to the conclusion that even noise is less important (Wolsink, 2007b). Drawing on the same as well as additional data (surveys with residents of wind turbines in southern Sweden, $n = 1105$), Pedersen and Larsman find that "[...] a negative visual attitude [...] enhanced the risk for noise annoyance" (Pedersen and Larsman, 2008, p. 379). But this point can be questioned since Langer et al. (2017) report a somewhat different order. They apply a hypothetical choice experiment on a panel sample of 1363 Germans aged 18 or above. The three attributes with the highest average relative importance values with respect to the acceptance of local wind energy projects are sound level at place of residence (first place), distance to place of residence (second place) and participation (third place). Visibility at place of residence is less important (Langer et al., 2017).

Visual effects are only relevant if the affected landscape is relevant to the people living there[6]. In this context, place attachment is often an important impact factor for the acceptance of wind turbines (Bell et al., 2005; Jones and Eiser, 2010; Liebe and Dobers, 2019). *Place attachment* can be defined as "[. . .] positive emotional bonds between people and valued environments [. . .]" (Devine-Wright, 2007, p. 7). It is important to say that place attachment can have positive or negative effects on local acceptance of wind energy depending on whether or not a wind farm fits with the meaning of the place (Devine-Wright, 2007; Di Nucci et al., 2020). Liebe and Dobers found that place attachment and protest intentions against renewable power plants (wind energy, solar energy, biomass) within a 10 km radius of the respondent's place of residence are positively correlated (Liebe and Dobers, 2019, p. 253). Jones and Eiser (2009, 2010) compare attitudes towards wind power in the UK and proposed sites for wind turbines of a sample from five cities near Sheffield which are all located within 1.5 km of these proposed wind turbines ($n = 417$, "target towns") with attitudes towards wind power and wind turbines of a sample from five cities that are further away ($n = 392$, "comparison towns"). They report for the target towns that the effect of considered site visibility on acceptance of local wind turbines was only apparent when the respondents held concerns about the landscape (Jones and Eiser, 2009, 2010, 3112 pp.).

But the findings are not always consistent. For example, Firestone and colleagues interviewed a large random sample of wind turbine residents in the USA ($n = 1705$) by telephone, internet and mail to investigate the perception and evaluation of local wind energy projects (Firestone et al., 2018). Contrary to the European findings, they did not reveal any effect of place attachment on the attitude towards local wind energy projects. The researchers also find "[...] that project appearance in general (its look) matters more than whether it fits the landscape" (Firestone et al., 2018, p. 379). Referring to value-orientated approaches like the cultural theory (Douglas and Wildavsky, 1993; Wildavsky and Dake, 1998), different values imply specific bias in perception and could serve as a possible explanation. Of course, this would question the transferability of national research results (Firestone et al., 2018; see also Aitken, 2010a). But this has to be tested by future research. All in all, high value of local places and perception of negative visual effects of wind turbines probably form a powerful source of resistance against such developments.

[6] "The visual impact of a wind energy landscape is indeed important, but this impact will fluctuate greatly across unique locations and societies. Levels of environmental concern will surely differ by location and will depend greatly on local context and place attachment" (Swofford and Slattery, 2010, p. 2514).

3.2 Proximity effects

It is clear that visual effects can only take part if the acceptance object can be seen (Bishop, 2002). This means that moving the object further away could lead to higher acceptance ("out of sight, out of mind"). This rationale is linked to the so called "proximity hypothesis" which states that "[...] those living closest to a wind farm will have the most negative perceptions of it [...]" (Harper et al., 2019, p. 956). Accordingly, wind energy projects should be more acceptable when they are realized offshore (meaning somewhere on the ocean and not to be seen or at least only be seen as a very small, non-disturbing part of the horizon) than onshore (somewhere in the country) or on the local level (somewhere in my neighbourhood). The empirical evidence for this hypothesis is rather mixed (Devine-Wright, 2005, 2007; Di Nucci et al., 2020; Harper et al., 2019; Jones and Eiser, 2010; Reusswig et al., 2016; Swofford and Slattery, 2010; Wolsink, 2007a, b).

For example, on the one hand, Jones and Eiser (2010) state that the acceptance of wind energy in the UK is in the target town group higher on a national level compared to the local level. In general, acceptance rises as distance increases. It is lowest on the local level, higher for onshore wind and highest for offshore wind (Jones and Eiser, 2010). This finding was successfully replicated by Sonnberger and Ruddat for Germany (Sonnberger and Ruddat, 2017), as well as Hübner and Hahn for three regions in Germany (non-representative-sample, $n = 704$; Hübner and Hahn, 2013). Swofford and Slattery (2010) also find evidence in favour of the proximity hypothesis on the basis of a mail survey in the USA conducted in 2009. They use a random sample of 200 residents of a wind farm with 75 wind turbines in Texas. The distance of respondents' home to the wind farm was up to 20 km. They report "[...] an inverse relationship between proximity and positive attitudes, whereby acceptance of wind energy decreases closer to the wind farm [...]" (Swofford and Slattery, 2010, p. 2514). In the same way, Langer and colleagues discover a relatively high relevance of distance to place of residence for the acceptance of wind energy projects, whereas "[...] respondents preferred larger distances between the wind turbines and their place of residence" (Langer et al., 2017, p. 68).

On the other hand, Hoen and colleagues report positive effects of proximity to wind turbines on acceptance using a randomly selected sample of residents near wind turbines in the USA ($n = 1705$; Hoen et al., 2019, p. 7). Wolsink interviewed 531 environmentalist (members of the Wadden Vereninging) and found no effect of distance on the attitude on the siting of wind turbines in the Wadden region (Wolsink, 2007b, p. 1199). Hübner and Pohl (2015) summarize findings of four studies with residents of wind turbines in different regions of Germany and Switzerland ($212 < n < 467$). Measuring distances on a metric scale (for example from less than 600 m to more than 2000 m) they found no correlation between distance to the nearest wind turbine and acceptance of wind energy in general as well as locally (Hübner and Pohl, 2015, p. 11).

Differences in results are not very surprising given the fact that the studies vary with respect to acceptance subject, acceptance object and acceptance context (Hüsing et al., 2002; Lucke, 1995; Schäfer and Keppler, 2013). Because social science research (especially in an international context) has always to deal with some degree of cultural variation, this is just natural. On the other side, this highlights the great importance of longitude research and cross-national studies. For example, Wolsink (1988, 1994, 2007a, b) reports a U-shaped curve of wind energy acceptance as a result of experimental studies conducted in the Netherlands (pre- and post-test control group design, $333 < n < 680$). He differentiates between three phases: before project planning, during the siting process and after the wind turbines started running. Although general attitudes towards wind power as well as local acceptance of wind farms are positive on average in all three phases, they are high in the first phase, relatively low in the second phase and high again in the third phase (Wolsink, 1988, 1994, 2007a, b). This positive effect of direct experience with the risk source has also been found in several other studies and countries (e.g. Ireland, Scotland and the USA; Krohn and Damborg, 1999; Swofford and Slattery, 2010; Warren et al., 2005). It can probably be traced back to overexaggerated expectations about the negative environmental impacts of the wind turbines (van der Horst and Toke, 2010; Warren et al., 2005). But it is certainly not an automatism. Wolsink states that "[. . .] it is by no means a guarantee for improvement of attitudes after a facility has been constructed. The effect can only be seen if the existing environmental impact is adequately dealt with, in the eyes of the local population" (Wolsink, 2007b, p. 1199)[7]. These research results help to explain at least in part the differing results with respect to the proximity hypothesis: wind turbines near residential areas can have a negative effect on acceptance in the case of *proposed sites* but a positive effect in the case of *existing sites*. This differentiation between proposed and existing sites is also emphasized in the literature (van der Horst, 2007; Hoen et al., 2019; Swofford and Slattery, 2010; Warren et al., 2005).

The proximity hypothesis can also be linked to the famous but at the same time outdated NIMBY ("not in my backyard") phenomenon (e.g. Aitken, 2010b; Breukers and Wolsink, 2007; Devine-Wright, 2007; van der Horst, 2007; Jones and Eiser, 2010; Sauter and Watson, 2007). It means "[...] that people have positive attitudes towards something (wind power) until they are actually confronted with it, and that they then oppose it for selfish reasons" (Wolsink, 2007b, p. 1199). NIMBY is problematic for at least three reasons. First, it is certainly not the only explanation for resistance (alternatives are, for example, place attachment or a lack of procedural fairness; Jones and Eiser, 2010; Wolsink, 2007b). Second, it is a very simplistic form of explanation (i.e. there are certainly more reasons for human behaviour than just selfishness; Bell et al., 2005; Devine-Wright, 2007; Wüstenhagen et al., 2007). Third, it is a one-sided negative label for respondents ("[...] it is never a complement to call someone a NIMBY [...]"; Haggett, 2011, p. 504). Although the negative consequences of the NIMBY concept are clearly acknowledged here, there is one convincing argument by Bell and colleagues who connect NIMBY to rational choice theory in order to explain the social gap:

> The Nimby explanation of the social gap is the only explanation that depends upon an individual gap between attitudes to wind power in general (unqualified positive) and attitudes to a particular development (negative) [. . .] On the Nimby account, the individual gap is the gap between collective rationality (or concern for the public good) which people will express in opinion surveys when it costs them nothing and individual rationality (or self-interest) which will motivate their behaviour. (Bell et al., 2005, p. 465)

This means "collective rationality" refers to the general support of wind energy (i.e. public acceptance), while "individual rationality" refers to local acceptance. This is in line with research findings referring to several distance measures of wind energy projects (local, onshore, offshore) instead of one overall measure of wind energy acceptance.

3.3 Trust

The role of trust for risk perception, risk management, (risk) acceptance and facility siting has been well researched in the last decades (e.g. Earle and Cvetkovich, 1995; Johnson, 1999; Renn and Levine, 1991; Slovic, 1993; Wüstenhagen et al., 2007). For example, the moderating effects of trust on risk and benefit perceptions are well known. If trust in relevant actors (e.g. official agencies, scientists, environmentalists, industry) is high, benefit also tends to be rated high

[7] This can be linked to the role of visual effects and place attachment (see Sect. 3.1).

and risks low and vice versa. This in turn has effects on risk acceptance (Siegrist, 2000, 2001).

Trust can be defined as "[...] a feeling or belief that someone (or some institution) will act in your best interest" (Bellaby, 2010, p. 2615). But why should someone or some institution do that for me? Earle and Cvetkovic argue that trust (or social trust as they call it because it is socially constructed) is based on value similarity (Earle and Cvetkovich, 1995[8]). People sharing common values can more easily trust each other. In the modern, complex world there are many new technologies and associated risks that no one and no institution can handle alone (Renn, 2008). This is one reason for the importance of trust. Additionally, a lot of people do not know much about these technologies. In such a situation of high complexity and little knowledge, trust becomes even more important. It reduces complexity to a certain degree and creates possibilities for joint action. Of course, trusting someone or some institution is a risk in itself because expectations always can be disappointed. In this case, trust is lost. In fact, it is lost very easily, and regaining it is (very) difficult (Huijts et al., 2007; Kasperson et al., 2003; Luhmann, 2014; Siegrist, 2001; Slovic, 1993).

Scholars regularly cite two central elements of trust: competence and care. *Competence* entails the technical knowledge and capabilities to rationally manage risks. Empirical indicators can be, for example, education, qualification or perceived performance in risk management. *Care* refers to the perceived responsibility to manage risks in the right way, which means acting on the basis of shared cultural values. Empirical indicators can be respect of the common good or honesty (Johnson, 1999; Huijts et al., 2007; Renn and Levine, 1991).

The *concept of trust* has been also used in the context of renewable energies in general and specifically wind energy. For example, Aitken (2010b) found in a Scottish case study some hints for the effects of distrust on the perception of unfair processes in the siting of wind energy projects. She notes that "[...] initial suspicions that the developers[9] would not act in the community's best interests led individuals to view decision-making processes concerning the development to be unfair. From the earliest stages the community benefits package was perceived as representing a bribe [...]" (Aitken, 2010b, p. 6074). Sonnberger and Ruddat (2017) deliver mixed evidence for the role of trust. On the one hand, a multiple regression analyses revealed only two significant correlations (out of 12 possible ones). Trust in big energy companies (the big four in Germany: E.ON, RWE, EnBW and Vattenfall) and the acceptance of offshore wind farms correlate negatively, and trust in big energy companies and the local acceptance of wind farms correlate positively (Sonnberger and Ruddat, 2017)[10]. On the other hand, a categorical principal component analysis with the same data showed the relevance of trust for risk perception of renewables. The analyses revealed risk–benefit/acceptance and trust/fairness as the two main latent dimensions underlying citizens' perception of the German energy system transition (Sonnberger and Ruddat, 2018)[11]. Jones and Eiser report effects of trust in the target town group of their study in Sheffield: "[...] the more target respondents trusted Sheffield City Council to act with due fairness and transparency when furthering their plans for wind development, the more likely they were to hold favourable attitudes towards development, and vice versa" (Jones and Eiser, 2009, p. 4609). Hall and et al. (2013) conducted a qualitative case study on wind energy in Australia (guideline interviews, $n = 27$). Municipality officials advised wind developers to be frank and open in communication processes to build up trust, and the wind developers used local multiplicators to generate trust (Hall et al., 2013). The relevance of local relationships and local foundation is also mentioned by Hübner and colleagues (Hübner et al., 2020), as well as Haggett (2011). In this respect, local ownership of wind projects is seen as relevant for generating trust and support (Jones and Eiser, 2009; Krohn and Damborg, 1999; Warren and McFadyen, 2010; Rand and Hoen, 2017). All in all, trust seems to be a key element for acceptance: "[...] establishing trust between the wind developer and affected stakeholders throughout the life of the wind farm is a theme with significant impact on the resulting level of social acceptance [...]" (Hall et al., 2013, p. 204).

3.4 Risk and benefit perceptions

The application of technologies always implicates benefits as well as risks (Fischhoff et al., 1981; Perlaviciute and Steg, 2014). There are no universally ideal options for the satisfaction of human needs like transportation, food, housing or energy production. The list of possible risks and benefits of wind energy is long. Examples for commonly cited benefits of large wind farms are economic development (e.g. creation of jobs), tax revenue, landowner and/or community compensation, reduced air pollution, and carbon savings. Examples for commonly cited risks of large wind farms are ecosystem impacts, visual impacts, sound annoyance and (perceived) health effects, as well as impacts to property values, tourism and so on (Boudet, 2019; Rand and Hoen, 2017). According to Bell et at. (2005), the perception of these positive and negative aspects of wind energy can be related to what they

[8] "Throughout its development, social trust was based on similarity of cultural values, and this was communicated within cultural groups by narratives constructed by community leaders. Social trust was socially based" (Earle and Cvetkovich, 1995, p. 19).

[9] According to Aitken, "[...] the developers are one of the largest energy companies in the UK" (Aitken, 2010b, p. 6070).

[10] One possible explanation for this contradiction could be the perception that the big energy companies do not really support the energy transition. Actually, this result was also found in focus groups (Ruddat and Sonnberger, 2015).

[11] These different results can at least partly be ascribed to the different methods of analyses.

call "qualified support", meaning people tend to accept wind energy not per se and unconditionally but instead only if certain conditions (i.e. an acceptable risk / benefit ratio) are met. This is another explanation for the social gap (Bell et al., 2005). Perlaviciute and Steg address collective as well as individual costs and benefits of energy applications: "People tend to ascribe high collective costs and low collective benefits to fossil fuels, including oil, coal, and gas, and to nuclear energy, whereas they tend to associate renewable energy sources with high collective benefits and low collective costs" (Perlaviciute and Steg, 2014, p. 363). This positive view of renewables (including wind energy) is not present on the individual level though. Irrespective of that, the relationship between costs and benefits on the one side and acceptance on the other side is clear for both levels: higher perceived costs correlate with lower acceptance and higher perceived benefits with higher acceptance (Perlaviciute and Steg, 2014, p. 363).

There is plenty of empirical evidence for the connection between the perception of risk–benefit and wind energy acceptance (e.g. Jones and Eiser, 2009; Walter and Gutscher, 2013; Sonnberger and Ruddat, 2017). Jones and Eiser (2009) use amongst others benefits like general economic benefit, opportunity to invest and cheaper electricity. Risks are, for example, the spoiling of the landscape, the lowering of house prices and a general unwanted change. Results show that these benefit and risk perceptions correlate significantly with specific attitudes towards wind energy turbines (i.e. local acceptance; Jones and Eiser, 2009). Walter and Gutscher (2013) used an experimental setting in a rural community in Bavaria (Germany) to analyse the effects of different wind energy projects on the perception of 350 respondents through a postal survey. Projects varied, amongst others, with respect to the implementation and result of a citizens' vote and the existence of local benefits. They found a significant effect of regional benefit (e.g. a community fund) on the support of specific wind projects (i.e. local acceptance; Walter and Gutscher, 2013). The study of Sonnberger and Ruddat revealed significant correlations of perceived risks of wind energy (index containing spoiling of the landscape, noise and danger for birds), as well as perceived benefits (creation of new jobs) and the acceptance of wind energy (offshore, onshore and local; Sonnberger and Ruddat, 2017).

3.5 Fairness and participation

Social scientists have repeatedly emphasized a demand for participation in the case of siting decisions (Allen, 1998; Rademacher et al., 2020; Renn, 2004). Residents perceive possible negative impacts of infrastructure planning (e.g. roads, power plants, waste facilities) for human health and the environment in their neighbourhood. Because the risks are solely taken by the local population while the whole society benefits from the infrastructure, questions of *distributive fairness* arise (Bell et al., 2005; Hall et al., 2013). A similar argument is contained in the "green on green conflict" which means risking the local environment for the sake of the global environment (e.g. Devine-Wright, 2007; Wolsink, 2007b; Swofford and Slattery, 2010)[12]. Haggett (2011) cites several studies documenting the gap between local risk and global benefit of offshore wind parks. Although all people on earth will benefit from successfully fighting climate change, the risks (e.g. environmental damage, negative effects on birds, fishes, fishing industry and tourism) are taken by the residents of the sites (Haggett, 2011).

Another part of the puzzle is *process fairness* meaning the appropriate participation of residents and other stakeholders in the decision-making process (Aitken, 2010b; Devine-Wright, 2007; Hall et al., 2013)[13]. Research has shown effects of both elements on the acceptance of new infrastructure (Firestone et al., 2018; Hoen et al., 2019; Wolsink, 2007a). For example, Hoen and colleagues find statistically significant positive effects of perceived process fairness on the attitude towards a wind turbine (Hoen et al., 2019, p. 7). Sonnberger and Ruddat report significant positive correlations between distributive and process fairness on the one hand and the acceptance of wind energy onshore and wind farms at a distance of 500 m from the respondent's home on the other hand (Sonnberger and Ruddat, 2017, p. 61). The relevance of distributive as well as process fairness with respect to the acceptance of wind turbines also shows up in the qualitative study of Hall et al. (2013, p. 205).

Participation of residents and other stakeholders in siting decisions is seen as one possible way to come to commonly agreed solutions, as well as to build up trust (Aitken, 2010b; Bell et al., 2005; Jones and Eiser, 2009; Klinke and Renn, 2002; Ruddat and Renn, 2012; Wolsink, 2007b). Although there is certainly no guarantee for success, "good participation" raises the chances to avoid or minimize conflict (Alcántara et al., 2016; Webler, 1995; Renn, 2004; Ruddat and Mayer, 2020; Schweizer-Ries et al., 2010). Like Breukers and Wolsink put it: "Participatory decision-making is unlikely to turn people who fundamentally oppose wind power into supporters. However, conditional supporters [...] may accept a wind project when they have been given an opportunity to influence the design" (Breukers and Wolsink, 2007, p. 2738).

People can participate directly in the planning process or financially. Krohn and Damborg report empirical evidence for the positive effect of financial participation on acceptance (Krohn and Damborg, 1999). Pasqualetti also emphasizes the

[12]Here again the argument of "qualified support" by Bell et al. (2005) plays a crucial role. If residents perceive a high distributional fairness, acceptance of nearby wind farms is more likely. The same is true if the "price" for the local environment is not too high.

[13]Some authors (e.g. Firestone et al., 2018; Hall et al., 2013) use the terms "distributional/distributive justice" and "procedural justice". Although there may be some differences between these formulations, they are used here interchangeably.

benefit for land owners in the USA through wind turbines on their property (Pasqualetti, 2001). In a mixed-method design using surveys, qualitative interviews, focus groups and workshops, Schweizer-Ries and colleagues examined the perception and evaluation of wind, solar and biomass energy in different German case studies and came to the conclusion that financial as well as planning participation can have positive effects on (local) acceptance (Schweizer-Ries et al., 2010). Hübner and colleagues arrive at the same conclusion (Hübner et al., 2020).

With respect to planning participation, Firestone et al. report a positive correlation between the perceived possibility of the community to influence the outcome of the siting process and the attitude towards the respective wind project (Firestone et al., 2018, p. 377). In the study of Langer and colleagues, participation was under the three attributes with the highest average relative importance values with respect to the acceptance of local wind energy projects (Langer et al., 2017, p. 68). Based on empirical evidence from several studies, Haggett asserts that "[...] opposition can be both because people perceive that they have no voice, or no power" and concludes that "the planning process for offshore projects should therefore ideally allow local people to have some say or even influence in the project [...]" (Haggett, 2011, p. 507).

4 Discussion, conclusion and some open questions

The goal of sustainable development means changing the energy supply in Germany and elsewhere from the use of fossil fuels and nuclear energy to renewable energies like wind, solar and biomass. Wind energy is of major importance for the success of this transformation process because it can provide large amounts of relatively cost-efficient energy. This transition process is not an easy task. Technical challenges (e.g. distribution and storage of fluctuating energy) have to be handled, and social aspects (e.g. the relation of lost and created jobs in the energy sector, new energy infrastructures in the vicinity of residential areas) have to be considered. This leads to the question of acceptance.

The concept of acceptance is complex as well as multidimensional. It encompasses attitudinal and behavioural elements and can be measured in many different ways. This review mainly dealt with public and local acceptance of wind energy, wind turbines and wind parks. Accordingly, acceptance means a positive evaluation of a topic (like wind energy, wind turbines or wind parks) by individuals under certain circumstances (e.g. cultural or institutional context) that can have consequences for individual behaviour. Correspondingly, non-acceptance means a negative evaluation of a topic by individuals under certain circumstances that can have consequences for individual behaviour. If there is no clear positive or negative attitude towards the topic (e.g. ambivalence, non-attitude), we speak of tolerance that can have consequences for individual behaviour (but perhaps not so much as the endpoints of the continuum). In general, public acceptance of wind energy is clearly positive in many countries of the European Union. This positive evaluation is even more apparent in comparison with conventional energy sources like coal, gas or nuclear power. Problems arise when looking at local acceptance of wind turbines or wind farms. The protest potential with respect to wind projects is clearly higher than the one for solar projects.

Social science research has identified several empirical drivers of public and (even more important) local acceptance. On the one hand, there is empirical evidence that perceived individual as well as collective benefits (e.g. creation of new jobs), trust in relevant actors of the transition process, procedural and distributional fairness, good management of environmental impacts (e.g. visual effects, noise, fit with the landscape), and early and effective participation in planning processes and financial involvement can have positive effects on wind energy acceptance. On the other hand, perceived risks (e.g. spoiling of the landscape, danger for birds, noise), the perception of missing procedural and distributional fairness, distrust of relevant actors of the transition process, and bad management of environmental impacts, as well as delayed and/or ineffective participation in planning processes ("alibi participation"), can have negative effects on wind energy acceptance.

There is a remarkable disproportion between the number of studies dealing with onshore and offshore wind. Articles about onshore wind parks are dominant in this review. This questions the validity of the results for offshore wind and highlights the need for more research in this area.

Of course, this is a rather rough summary of the state of research. Section 3 has presented numerous quantitative as well as qualitative studies which demonstrate rich and diverse findings. They differ in accordance to research design, as well as place and date of research. On the one hand, this accounts for the complexity and multidimensionality of acceptance and is therefore an advantage. Ideally, if findings can be replicated under varying situations, they stand on a more solid ground.

On the other hand, it raises questions concerning the comparability of research results[14] and is as such a disadvantage. Although quantitative studies using large (representative) samples and statistical analyses produce seemingly "hard" evidence, they may differ with respect to sampling, wording and other relevant aspects. Because of that, it may seem difficult to compare different quantitative studies. Indeed, this is sometimes challenging, and it should always be kept in mind that conceptualizations and measurement usually differ between quantitative studies at least to a certain degree (Aitken, 2010a). The case is even more complicated for qualitative studies. They include a quite different kind of

[14] I am totally aware that this may be a very critical topic for some researchers. Unfortunately, this cannot be discussed here in further detail.

sampling, data collection and analyses. It is indeed the individual context of the research situation that enables the researcher to interpret the results. Comparability is only (if at all) possible on a very abstract level (e.g. the categories of content analyses). In every case, the reader should always have a closer look at the research design to be aware of the differences. This also highlights the importance of longitudinal as well as cross-cultural studies (e.g. Breukers and Wolsink, 2007; IASS, 2020; Steentjes et al., 2017). Longitudinal studies are of high value for social science research, especially when they are conducted in different countries and allow for comparisons over time, as well as between different cultures. This kind of data allows for the proper consideration of the dynamic nature of acceptance. Additionally, considering aspects like the financial system, support programmes, local context or planning legislation in a systematic manner can better account for the complexity of acceptance. This should be taken into account in future research.

Another relevant question arises with respect to distributional fairness. Although empirical research has identified the fair distribution of benefits and risks as an important factor of wind energy acceptance, it is still unclear what this exactly means. Who considers what distribution of benefits and risks under what kind of circumstances as fair? This would probably be a good starting point for more valuable cross-cultural research in this field.

Participation in planning processes for the siting of infrastructure (e.g. wind farms) is usually assumed to be case specific and context dependent (Aitken, 2010b; de Vente et al., 2016; Hübner et al., 2020; Nanz and Fritsche, 2012). Because the site and the surrounding environment, as well as the cultural and social background, vary, participation concepts and corresponding measurements have to vary, too. This is certainly true. But it is also very time demanding, costly and inefficient. The question arises of whether it is possible to find certain types of siting processes and to develop suitable types of participation concepts for them. The types of siting processes for wind farms could be structured by place (e.g. offshore vs. onshore), size (e.g. few wind turbines vs. many wind turbines) or social factors (e.g. rural vs. urban areas). These are just a few ideas from the existing research. Future comprehensive studies including a mixed quantitative–qualitative design could of course reveal other important structural factors.

Finally, the mixed evidence concerning the proximity hypothesis leads to the question of whether or not they can be integrated. One possibility linked to the empirical results concerning the U-shaped form of acceptance could be the differentiation between proposed and existing wind farms. But this would just be a starting point on the road to a more comprehensive theoretical concept or framework. Examples for such integrative theoretical frameworks are the elaboration likelihood model (ELM; Petty and Cacioppo, 1986; Petty and Wegener, 1999) and the social amplification of risk framework (SARF; Kasperson et al., 1988, 2003; Renn et al., 1992). Additionally, it could be asked how proximity can be operationalized in the right way since the relationships between the distance of wind farms and the local acceptance of residents seem to vary with scale. If distances are measured on a metric scale, there is no relationship. If distances are measured using ordinal scales (e.g. 500 m, 5 km, onshore, offshore), relationships show up as expected. It is probably not just the physical distance alone that constitutes opposition or support but the *meaning* of the different distances for the residents (i.e. social construction of distance; Devine-Wright, 2005). What do they perceive to be their neighbourhood? How big is it really? This may vary between social groups, as well as between different cultures. Taken together, this review has shown that despite a lot of valuable scientific work done up to now, there are still some open questions left.

Data availability. No data sets were used in this article.

Competing interests. The author has declared that there are no competing interests.

Disclaimer. Publisher's note: Copernicus Publications remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Financial support. This open-access publication was funded by the University of Stuttgart.

Review statement. This paper was edited by Bonnie Ram and reviewed by three anonymous referees.

References

AEE – Agentur für Erneuerbare Energien: Akzeptanz in der Fläche, Protest im Lokalen? Studie zur Windenergie an Land, AEE, Renews Spezial 90, Berlin, https://www.unendlich-viel-energie.de, last access: 30 December 2020.

Aitken, M.: Why we still don't understand the social aspects of wind power: A critique of key assumptions within the literature, Energ. Policy, 38, 1834–1841, https://doi.org/10.1016/j.enpol.2009.11.060, 2010a.

Aitken, M.: Wind power and community benefits. Challenges and opportunities, Energ. Policy, 38, 6066–6075, https://doi.org/10.1016/j.enpol.2010.05.062, 2010b.

Alcántara, S., Bach, N., Kuhn, R., and Ullrich, P.: Demokratietheorie und Partizipationspraxis – Analyse und Anwendungspotentiale deliberativer Verfahren, Springer VS, ISBN 978-3-658-11220-2, 2016.

Ajzen, I.: The Theory of Planned Behavior, Organ. Behav. Hum. Dec., 50, 179–211, https://doi.org/10.1016/0749-5978(91)90020-T, 1991.

Ajzen, I. and Fishbein, M.: Understanding Attitudes and Predicting Social Behavior, Prentice-Hall, Englewood Cliffs, New Jersey, ISBN 9780139364433, 1980.

Allen, P. T.: Public Participation in Resolving Environmental Disputes and the Problem of Representativeness, Risk: Health, Safety and Environment, 297, 297–308, 1998.

Bell, D., Gray, T., and Haggett, C.: The "Social Gap" in Wind Farm Siting Decisions. Explanations and Policy Responses, Environ. Polit., 14, 460–477, https://doi.org/10.1080/09644010500175833, 2005.

Bellaby, P.: Foreword to Theme 1: Concepts of trust and methods for investigating it, Energ. Policy, 38, 2615–2616, https://doi.org/10.1016/j.enpol.2009.05.034, 2010.

Bishop, I. D.: Determinants of threshold of visual impact: the case of wind turbines, Environ. Plann. B, 29, 707–718, https://doi.org/10.1068/b12854, 2002.

Böhm, G. and Tanner, C.: Environmental Risk Perception, in: Environmental Psychology – An Introduction, 2nd Edn., edited by: Steg, L. and De Groot, J. I. M., Wiley, NJ, 16–25, ISBN 9781119241041, 2019.

Boudet, H. S.: Public perceptions of and responses to new energy technologies, Nature Energy, 4, 446–455, https://doi.org/10.1038/s41560-019-0399-x, 2019.

Breukers, S. and Wolsink, M.: Wind power implementation in changing institutional landscapes: An international comparison, Energ. Policy, 35, 2737–2750, https://doi.org/10.1016/j.enpol.2006.12.004, 2007.

Cohen, J. J., Reichl, J., and Schmidthaler, M.: Refocussing research efforts on the public acceptance of energy infrastructure. A critical review, Energy, 76, 4–9, https://doi.org/10.1016/j.energy.2013.12.056, 2014.

De Vente, J., Reed, M. S., Stringer, L. C., Valente, S., and Newig, J.: How does the context and design of participatory decision making processes affect their outcomes? Evidence from sustainable land management in global dry-lands, Ecol. Soc., 21, 24, https://doi.org/10.5751/ES-08053-210224, 2016.

Devine-Wright, P.: Beyond NIMBYism. Towards an Integrated Framework for Understanding Public Perceptions of Wind Energy, Wind Energy, 8, 125–139, https://doi.org/10.1002/we.124, 2005.

Devine-Wright, P.: Reconsidering public attitudes and public acceptance of renewable energy technologies: a critical review, Working Paper 1.4, School of Environment and Development, University of Manchester, http://geography.exeter.ac.uk/beyond_nimbyism/deliverables/bn_wp1_4.pdf (last access: 6 May 2015), 2007.

Di Nucci, M. R., Krug, M., Will, A., and Vondran, S.: Akzeptanzfaktoren und akzeptanzfördernde Maßnahmen beim Ausbau der Windenergie, Energiewirtschaftliche Tagesfragen, 70, 29–34, 2020.

Douglas, M. and Wildavsky, A.: Risiko und Kultur, in: Riskante Technologien, edited by: Krohn, W. and Krücken, G., Frankfurt a. M., 113–138, ISBN 978-3-518-28698-2, 1993.

Eagly, A. H. and Chaiken, S.: The Psychology of Attitudes, Wadsworth, Belmont, http://refhub.elsevier.com/S2214-6296(21)00101-8/h0375 (last access: 5 August 2022), 1993.

Earle, T. C. and Cvetkovich, G. T.: Social Trust – Toward a Cosmopolitan Society, Praeger, Westport, ISBN 0-275-94845-5, 1995.

Ellis, G. and Ferraro, G.: The social acceptance of wind energy. Where we stand and the path ahead, JRC Science for Policy Report, https://doi.org/10.2789/696070, 2016.

European Commission: Public Awareness and Acceptance of CO_2 capture and storage, Report, Special Eurobarometer 364, Wave 75.1, TNS Opinion & Social, European Commission, https://europa.eu/eurobarometer/surveys/detail/848 (last access: 5 August 2022), 2011.

FA Wind (Fachagentur Wind an Land): Umfrage zur Akzeptanz der Windenergie an Land – Herbst 2020. Ergebnisse einer repräsentativen Umfrage zur Akzeptanz der Nutzung und des Ausbaus der Windenergie an Land in Deutschland, FA Wind, Berlin, https://www.fachagentur-windenergie.de, last access: 30 December 2020.

Firestone, J., Hoen, B., Rand, J., Elliot, D., Hübner, G., and Pohl, J.: Reconsidering barriers to wind power projects: community engagement, developer transparency and place, J. Environ. Pol. Plan., 20, 370–386, https://doi.org/10.1080/1523908X.2017.1418656, 2018.

Fischhoff, B., Lichtenstein, S., Slovic, P., Derby, S., and Keeney, R.: Acceptable Risk, Cambridge University Press, ISBN 13 978-0521241649, 1981.

Groth, T. M. and Vogt, C.: Residents' perceptions of wind turbines: An analyses of two townships in Michigan, Energ. Policy, 65, 251–260, https://doi.org/10.1016/j.enpol.2013.10.055, 2014.

Haggett, C.: Understanding public responses to offshore wind power, Energ. Policy, 39, 503–510, https://doi.org/10.1016/j.enpol.2010.10.014, 2011.

Hall, N., Ashworth, P., and Devine-Wright, P.: Societal acceptance of wind farms. Analysis of four common themes across Australian case studies, Energ. Policy, 58, 200–208, https://doi.org/10.1016/j.enpol.2013.03.009, 2013.

Harper, M., Anderson, B., James, P. A. B., and Bahaj, A. S.: Onshore wind and the likelihood of planning acceptance: Learning from a Great Britain context, Energ. Policy, 128, 954–966, https://doi.org/10.1016/j.enpol.2019.01.002, 2019.

Hildebrand, J., Rau, I., and Schweizer-Ries, P.: Akzeptanz und Beteiligung. Ein ungleiches Paar, in: Handbuch Energiewende und Partizipation, edited by: Holstenkamp, L. and Radtke, J., Springer VS, Wiesbaden, 195–210, https://doi.org/10.1007/978-3-658-09416-4, 2017.

Hoen, B., Firestone, J., Rand, J., Elliot, D., Hübner, G., Pohl, J., Wiser, R., Lantz, E., Haac, T. R., and Kaliski, K.: Attitudes of U. S. Wind Turbine Neighbors: Analysis of a Nationwide Survey, Energ. Policy, 134, 1–11, https://doi.org/10.1016/j.enpol.2019.110981, 2019.

Hübner, G. and Hahn, C.: Akzeptanz des Stromnetzausbaus in Schleswig-Holstein, Abschlussbericht zum Forschungsprojekt, Halle, http://www.akzeptanz-offshore-windenergie.de/downloads/106/Forschungsbericht.pdf (last access: 5 August 2022), 2013.

Hübner, G. and Pohl, G.: Mehr Abstand – mehr Akzeptanz? Ein umweltpsychologischer Studienvergleich, Fachagentur Windenergie an Land, Berlin, https://www.fachagentur-windenergie.de/fileadmin/files/Akzeptanz/FA-Wind_Abstand-Akzeptanz_Broschuere_2015.pdf (last access: 5 August 2022), 2015.

Hübner, G., Pohl, J., Warode, J., Gotchev, B., Ohlhorst, D., Krug, M., Salecki, S., and Peters, W.: Akzeptanzfördernde Faktoren erneuerbarer Energien, BfN-Skripte 551, Bonn, https://doi.org/10.19217/skr551, 2020.

Huijts, N. M. A., Midden, C. J. H., and Meijnders, A. L.: Social acceptance of carbon dioxide storage, Energ. Policy, 35, 2780–2789, https://doi.org/10.1016/j.enpol.2006.12.007, 2007.

Hüsing, B., Bierhals, R., Bührlen, B., Friedewald, M., Kimpeler, S., Menrad, K., Wengel, J., Zimmer, R., and Zoche, P.: Technikakzeptanz und Nachfragemuster als Standortvorteil, Abschlussbericht, Fraunhofer-Institut für Systemtechnik und Innovationsforschung (Frauenhofer ISI), Karlsruhe, https://publica-rest.fraunhofer.de/server/api/core/bitstreams/6e7b3140-1129-4ebe-999d-c25b49382bf6/content (last access: 5 August 2022), 2002.

IASS – Institute for Advanced Sustainable Studies: Soziales Nachhaltigkeitsbarometer der Energiewende 2019, IASS, Potsdam, https://doi.org/10.2312/iass.2020.010, 2020.

Johnson, B. B.: Exploring dimensionality in the origins of hazard-related trust, J. Risk. Res., 2, 325–354, https://doi.org/10.1080/136698799376763, 1999.

Jones, C. R. and Eiser, J. R.: Identifying predictors of attitudes towards local onshore wind development with reference to an English case study, Energ. Policy, 37, 4604–4614, https://doi.org/10.1016/j.enpol.2009.06.015, 2009.

Jones, C. R. and Eiser, J. R.: Understanding "local" opposition to wind development in the UK. How big is a backyard?, Energ. Policy, 38, 3106–3117, https://doi.org/10.1016/j.enpol.2010.01.051, 2010.

Kasperson, J. X., Kasperson, R. E., Pidgeon, N., and Slovic, P.: The social amplification of risk: assessing fifteen years of research and theory, in: The social amplification of risk, edited by: Pidgeon, N., Kasperson, R. E., and Slovic, P., Cambridge University Press, Cambridge, 13–46, https://doi.org/10.1017/CBO9780511550461, 2003.

Kasperson, R. E., Renn, O., Slovic, P., Brown, H. S., Emel, J., Goble, R., Kasperson, J. X., and Ratick, S.: The Social Amplification of Risk: A Conceptual Framework, Risk Anal., 8, 177–187, https://doi.org/10.1111/j.1539-6924.1988.tb01168.x, 1998.

Klinke, A. and Renn, O.: A New Approach to Risk Evaluation and Management: Risk-Based, Precaution-Based, and Discourse-Based Strategies, Risk Anal., 22, 1071–1094, https://doi.org/10.1111/1539-6924.00274, 2002.

Krohn, S. and Damborg, S.: On Public Attitudes Towards Wind Power, Renew. Energ., 16, 954–960, https://doi.org/10.1016/S0960-1481(98)00339-5, 1999.

Langer, K., Decker, T., and Menrad, K.: Public participation in wind energy projects located in Germany: Which form of participation is the key to acceptance?, Renew. Energ., 112, 63–73, https://doi.org/10.1016/j.renene.2017.05.021, 2017.

Liebe, U.: Zahlungsbereitschaft für kollektive Umweltgüter – Soziologische und ökonomische Analysen, VS Verlag für Sozialwissenschaften, Wiesbaden, https://doi.org/10.1007/978-3-531-90464-1, 2007.

Liebe, U. and Dobers, G. M.: Decomposing public support for energy policy: What drives acceptance of and intentions to protest against renewable energy expansion in Germany?, Energy Research & Social Science, 47, 247–260, https://doi.org/10.1016/j.erss.2018.09.004, 2019.

Lucke, D.: Akzeptanz. Legitimität in der "Abstimmungsgesellschaft", Leske + Budrich, Opladen, https://doi.org/10.1007/978-3-663-09234-6, 1995.

Luhmann, N.: Vertrauen. Ein Mechanismus der Reduktion sozialer Komplexität, 5th edn., Stuttgart, ISBN 9783838540047, 2014.

Nanz, P. and Fritsche, M.: Handbuch Bürgerbeteiligung, Bundeszentrale für politische Bildung, Bonn, https://www.bpb.de/system/files/dokument_pdf/Handbuch_Buergerbeteiligung.pdf (last access: 5 August 2022), 2012.

Pasqualetti, M. J.: Wind Energy Landscapes: Society and Technology in the California Desert, Society and Natural Ressources, 14, 689–699, https://doi.org/10.1080/08941920152524882, 2001.

Pedersen, E. and Larsman, P.: The impact of visual factors on noise annoyance among people living in the vicinity of wind turbines, J. Environ. Psychol., 28, 379–389, https://doi.org/10.1016/j.jenvp.2008.02.009, 2008.

Pedersen, E. and Persson Waye, K.: Perception and annoyance due to wind turbine noise – a dose-response relationship, J. Acoust. Soc. Am., 116, 3460–3470, https://doi.org/10.1121/1.1815091, 2004.

Perlaviciute, G. and Steg, L.: Contextual and psychological factors shaping evaluations and acceptability of energy alternatives: Integrated review and research agenda, Renew. Sust. Energ. Rev., 35, 361–381, https://doi.org/10.1016/j.rser.2014.04.003, 2014.

Petermann, T. and Scherz, C.: TA und (Technik-)Akzeptanz(-forschung), Technikfolgenabschätzung – Theorie und Praxis, 14, 45–53, 2005.

Petty, R. E. and Cacioppo, J. T.: The Elaboration Likelihood Model of Persuasion, Adv. Exp. Soc. Psychol., 19, 123–205, 1986.

Petty, R. E. and Wegener, D. T.: The Elaboration Likelihood Model: Current Status and Controversies, in: Dual Processes Theories in Social Psychology, edited by: Chaiken, S. and Trope, Y., The Guilford Press, New York, 41–72, ISBN 9781572304215, 1999.

Rademacher, L., Lintemeier, K., and Kretschmer, H.: Öffentlichkeitsbeteiligung bei Infrastrukturprojekten als Herausforderung für Politik und Verwaltung, in: Öffentliche Verwaltung – Verwaltung in der Öffentlichkeit, edited by: Kocks, K., Knorre, S., and Knocks, J. N., Springer VS, 165–184, https://doi.org/10.1007/978-3-658-28008-6, 2020.

Rand, J. and Hoen, B.: Thirty years of North American wind energy acceptance research: What have we learned?, Energy Research & Social Science, 29, 135–148, https://doi.org/10.1016/j.erss.2017.05.019, 2017.

Renn, O.: Risikowahrnehmung der Kernenergie, Campus, Frankfurt am Main, ISBN 978-3-593-33043-3, 1984.

Renn, O.: The Challenge of Integrating Deliberation and Expertise: Participation and Discourse in Risk Management, in: Risk Analysis and Society: An Interdisciplinary Characterization of the Field, edited by: McDaniels, T. L. and Small, M. J., Cambridge University Press, Cambridge, 289–366, https://doi.org/10.1017/CBO9780511814662, 2004.

Renn, O.: Risk Governance – Coping with Uncertainty in a Complex World, Earthscan, London, ISBN 9781844072927, 2008.

Renn, O. and Levine, D.: Credibility and trust in risk communication, in: Communicating risks to the public: International perspectives, edited by: Kasperson, R. E. and Stallen, P. J. M., Kluwer Academic Publishers, Dordrecht, 175–218, https://doi.org/10.18419/opus-7321, 1991.

Renn, O., Burns, W. J., Kasperson, J. X., Kasperson, R. E., and Slovic, P.: The Social Amplification of Risk: Theoretical Foundations and Empirical Applications, J. Soc. Issues, 48, 137–160, https://doi.org/10.1111/j.1540-4560.1992.tb01949.x, 1992.

Reusswig, F., Braun, F., Heger, I., Ludewig, T., Eichenauer, E., and Wiebke, L.: Against the wind: Local opposition to the German Energiewende, Util. Policy, 41, 214–227, https://doi.org/10.1016/j.jup.2016.02.006, 2016.

Ruddat, M. and Mayer, V.: Wie beteiligen? Die Sicht der Verwaltung auf kommunale Partizipationsprozesse anhand von Fallbeispielen in Herrenberg und Stuttgart, Stuttgarter Beiträge zur Risiko- und Nachhaltigkeitsforschung, Nr. 38, Stuttgart, https://doi.org/10.18419/opus-10839, 2020.

Ruddat, M. and Renn, O.: Wie die Energiewende in Baden-Württemberg gelingen kann, Energiewirtschaftliche Tagesfragen, 62, 59–62, 2012.

Ruddat, M. and Sonnberger, M.: Wie die Bürgerinnen und Bürger ihre Rolle bei der Energiewende sehen, Energiewirtschaftliche Tagesfragen, 65, 121–125, 2015.

Ruddat, M. and Sonnberger, M.: Von Protest bis Unterstützung – eine empirische Analyse lokaler Akzeptanz von Energietechnologien im Rahmen der Energiewende in Deutschland, Kolner Z. Soziol. Soz., 71, 437–455, https://doi.org/10.1007/s11577-019-00628-4, 2019.

Sauer, A., Frieder L., Suda, M., and Weiland, U.: Steigerung der Akzeptanz von FFH-Gebieten, BfN-Skripte 144, München, https://www.bfn.de/fileadmin/MDB/documents/skript144.pdf (last access: 26 April 2018), 2005.

Sauter, R. and Watson, J.: Strategies for the deployment of microgeneration: Implications for social acceptance, Energ. Policy, 35, 2770–2779, https://doi.org/10.1016/j.enpol.2006.12.006, 2007.

Schäfer, M. and Keppler, D.: Modelle der technikorientierten Akzeptanzforschung. Überblick und Reflexion am Beispiel eines Forschungsprojekts zur Implementierung innovativer technischer Energieeffizienz-Maßnahmen, Discussion Paper des Zentrums für Technik und Gesellschaft, Nr. 34, Technische Universität Berlin, http://www.tu-berlin.de/ztg/menue/publikationen/discussion_papers/ (last access: 4 May 2018), 2013.

Schwarz, N.: Feelings as Information: Moods Influence Judgements and Processing Strategies, in: Heuristics and Biases: The Psychology of Intuitive Judgement, edited by: Gilovich, T., Griffin, D., and Kahnemann, D., Cambridge University Press, 534–547, https://doi.org/10.1017/CBO9780511808098, 2002.

Schweizer-Ries, P.: Energy sustainable communities. Environmental psychological investigations, Energ. Policy, 36, 4126–4135, https://doi.org/10.1016/j.enpol.2008.06.021, 2008.

Schweizer-Ries, P., Rau, I., and Zoellner, J.: Aktivität und Teilhabe – Akzeptanz Erneuerbarer Energien durch Beteiligung steigern, Projektabschlussbericht, Magdeburg, https://www.researchgate.net/publication/271197704_Aktivitat_und_Teilhabe_-_Akzeptanz_Erneuerbarer_Energien_durch_Beteiligung_steigern (last access: 5 August 2022), 2010.

Siegrist, M.: The Influence of Trust and Perceptions of Risks and Benefits on the Acceptance of Gene Technology, Risk Anal., 20, 195–204, https://doi.org/10.1111/0272-4332.202020, 2000.

Siegrist, M.: Die Bedeutung von Vertrauen bei der Wahrnehmung und Bewertung von Risiken, Arbeitsbericht, Akademie für Technikfolgenabschätzung in Baden-Württemberg, Nr. 197, Akademie für Technikfolgenabschätzung in Baden-Württemberg, Stuttgart, https://doi.org/10.18419/opus-8678, 2001.

Slovic, P.: Perception of Risk, Science, 236, 280–285, https://doi.org/10.1126/science.3563507, 1987.

Slovic, P.: Perceived Risk, Trust and Democracy, Risk Anal., 13, 675–682, https://doi.org/10.1111/j.1539-6924.1993.tb01329.x, 1993.

Slovic, P., Finucane, M. L., Peters, E., and McGregor, D. E.: Risk as Analysis and Risk as Feelings: Some Thoughts about Affect, Reason, Risk and Rationality, Risk Anal., 24, 311–322, https://doi.org/10.1111/j.0272-4332.2004.00433.x, 2004.

Sonnberger, M. and Ruddat, M.: Die gesellschaftliche Wahrnehmung der Energiewende – Ergebnisse einer deutschlandweiten Repräsentativbefragung. Unter Mitwirkung von: Oliver Wedderhoff und Antje Salup (beide Fraunhofer-Institut für Solare Energiesysteme ISE), Stuttgarter Beiträge zur Risiko- und Nachhaltigkeitsforschung, Nr. 34, Stuttgart, https://doi.org/10.18419/opus-9018, 2016.

Sonnberger, M. and Ruddat, M.: Local and socio-political acceptance of wind farms in Germany, Technol. Soc., 51, 56–65, https://doi.org/10.1016/j.techsoc.2017.07.005, 2017.

Sonnberger, M. and Ruddat, M.: Disclosing Citizens' Perceptual Patterns of the Transition to Renewable Energy in Germany, Nat. Cult., 13, 253–280, https://doi.org/10.3167/nc.2018.130204, 2018.

Starr, C.: Social Benefits versus Technological Risk, Science, 165, 1232–1238, 1969.

Steentjes, K., Pidgeon, N., Poortinga, W., Corner, A., Arnold, A., Böhm, G., Mays, C., Poumadère, M., Ruddat, M., Scheer, D., Sonnberger, M., and Tvinnereim, E.: European Perceptions of Climate Change: Topline findings of a survey conducted in four European countries in 2016, Cardiff University, Cardiff, https://orca.cardiff.ac.uk/id/eprint/98660/7/EPCC.pdf (last access: 5 August 2022), 2017.

Swofford, J. and Slattery, M.: Public attitudes of wind energy in Texas. Local communities in close proximity to wind farms and their effect on decision-making, Energ. Policy, 38, 2508–2519, https://doi.org/10.1016/j.enpol.2009.12.046, 2010.

Upham, P., Oltra, C., and Boso, A.: Towards a cross-paradigmatic framework of the social acceptance of energy systems, Energy Research & Social Science, 8, 100–112, https://doi.org/10.1016/j.erss.2015.05.003, 2015.

Van der Horst, D.: NIMBY or not? Exploring the relevance of location and the politics of voiced opinions in renewable energy siting controversies, Energ. Policy, 35, 2705–2714, https://doi.org/10.1016/j.enpol.2006.12.012, 2007.

Van der Horst, D. and Toke, D.: Exploring the landscape of wind farm developments; local area characteristics and planning process outcomes in rural England, Land Use Policy, 27, 214–221, https://doi.org/10.1016/j.landusepol.2009.05.006, 2010.

Walter, G. and Gutscher, H.: Generelle Befürwortung von Windkraftanlagen vor Ort vs. Befürwortung spezifischer Windkraftprojekte: Der Einfluss von Projekt- und Verfahrensparametern, Umweltpsychologie, 17, 124–144, 2013.

Warren, C. R. and McFadyen, M.: Does community ownership affect public attitudes to wind energy? A case study from south-west Scotland, Land Use Policy, 27, 204–213, https://doi.org/10.1016/j.landusepol.2008.12.010, 2010.

Warren, C. R., Lumsden, C., O'Dowd, S., and Birnie, R. V.: "Green On Green": public perceptions of wind power in Scotland and Ireland, J. Environ. Plann. Man., 48, 853–875, https://doi.org/10.1080/09640560500294376, 2005.

Webler, T.: "Right" Discourse in Citizen Participation: An Evaluative Yardstick, in: Fairness and Competence in Citizen Participation – Evaluating New Models for Environmental Discourse, edited by: Renn, O., Webler, T., and Wiedmann, P., Kluwer, Dordrecht and Boston, 35–86, https://doi.org/10.1007/978-94-011-0131-8, 1995.

Wildavsky, A. and Dake, K.: Theories of Risk Perception: Who Fears What and Why?, in: Risk and modern Society, edited by: Löfstedt, R. and Frewer, F., Earthscan Publications, London, 101–114, ISBN 10 1853834998, 1998.

Wolsink, M.: The social impact of a large wind turbine, Environ. Impact. Asses., 8, 323–334, 1988.

Wolsink, M.: Entanglement of Interests and Motives: Assumptions behind the NIMBY-theory on Facility Siting, Urban Stud., 31, 851–866, 1994.

Wolsink, M.: Planning of renewable schemes: Deliberative and fair decision-making on landscape issues instead of reproachful accusations of non-cooperation, Energ. Policy, 35, 2692–2704, https://doi.org/10.1016/j.enpol.2006.12.001, 2007a.

Wolsink, M.: Wind power implementation. The nature of public attitudes: Equity and fairness instead of "backyard motives", Renew. Sust. Energ. Rev., 11, 1188–1207, https://doi.org/10.1016/j.rser.2005.10.005, 2007b.

Wüstenhagen, R., Wolsink, M., and Bürer, M. J.: Social acceptance of renewable energy innovation: An introduction to the concept, Energ. Policy, 35, 2683–2691, 2007.