Community Responses to Airborne Wind Energy: What the Evidence Really Says

A short overview of the research landscape with insights for practice and policy

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This report synthesizes the findings of the first comprehensive empirical research on the community acceptance of Airborne Wind Energy (AWE). While technical feasibility and economic viability are often the primary focus of emerging technologies, history demonstrates that acceptance is frequently the deciding factor in the successful deployment of renewable energy projects. This document translates academic data into actionable insights for policymakers, regulators, and the AWE industry.

Disclaimer

This report is based on empirical research on community acceptance of AWE conducted in specific case study contexts. All statistical relationships reported are correlational and should not be interpreted as causal in nature. The findings and recommendations are intended as evidence-informed guidance and do not constitute legal advice or binding standards for policy or project development.

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At a glance: what this report offers

Airborne wind energy (AWE) is being developed as a complement to conventional wind turbines. By flying tethered kites in strong high-altitude winds, AWE aims to generate electricity with less material, more flexibility, and potentially lower environmental impacts. As the sector moves from prototypes toward larger demonstrators and eventual commercial deployment, community acceptance will be a key factor in determining whether and where AWE can be built.

This report offers an overview of what is currently known about community responses to AWE, focusing on the first empirical studies conducted for a doctoral dissertation. It is written for people who make or influence decisions about AWE: developers and operators, permitting authorities and regulators, policymakers, funders, and researchers. Readers will find a summary of the empirical patterns observed and their practical and policy implications. The evidence base combines four strands: a literature review; a field study comparing residents' responses to an AWE system and a nearby wind farm in Germany; a survey of residents near test sites in Germany and Ireland; and a controlled listening experiment on AWE noise. Together, these studies provide the first systematic picture of how communities currently perceive AWE and what predicts acceptance.

Three main findings stand out. *First*, current data do not support the widespread idea that AWE is automatically more acceptable than wind turbines. In the German field study, residents perceived the AWE system as less visually intrusive than the wind farm but reported similar sound, safety, and ecological impacts. *Second*, a set of factors predicts community acceptance of AWE: noise annoyance, visual impacts, and annoyance from aviation lights explain lower acceptance, while perceived transparency and developer fairness predict higher acceptance. *Third*, noise emerged as a critical issue. In the listening experiment, recordings of fixed-wing kites tended to be rated as more annoying than those of soft-wing kites due to sharper and more tonal sound characteristics. Annoyance ratings were related to psychoacoustic indicators, such as sharpness, and individual factors, including noise sensitivity, age, and familiarity with AWE. Notably, participants familiar with AWE reported lower annoyance to subjectively louder recordings, illustrating how knowledge influences sound perception.

Overall, the emerging picture is that community responses to AWE resemble those observed for wind farms: Perceived impacts and perceptions of transparency and fairness are central. Noise annoyance reflects a combination of objective acoustic features and subjective factors such as noise sensitivity and perceived fairness.

Based on these findings, three conclusions can be drawn. Optimism about AWE is necessary to sustain investment and innovation but must be grounded in empirical evidence rather than assumptions. Social acceptance is as critical as technical performance and must be treated as such in the design, deployment, and regulation of systems. And community responses depend not only on measurable project impacts, but also on subjective and contextual factors influenced by how projects are planned, communicated, and governed.

For developers and operators, the findings underscore the need to treat acceptance as a design and operational consideration, to address noise and light emissions systematically, and to use test sites for long-term engagement rather than short-term demonstrations. **For policymakers and regulators**, they point to the importance of AWE-specific rules, setting standards for community engagement, and standardized monitoring and data collection. **For funders and researchers**, they highlight the value of interdisciplinary, longitudinal, and comparative studies that keep pace with technological advancements. Addressing these social dimensions early offers the sector an opportunity to build AWE in partnership with communities, avoiding mistakes from the history of wind energy deployment.

1. Why community acceptance of AWE matters

The energy system is a socio-technical system: infrastructure is embedded in landscapes, communities, and institutions.[1,2] **Decisions about where and how to build renewable energy projects are as much political and social as they are technical**. Decades of research on wind energy show that social challenges can slow down or derail projects.[3,4] Residents' complaints about noise, visual impact, and perceived unfairness are often dismissed as selfish or irrational.[5–7] Technological or regulatory "fixes" are sometimes sought for problems that are, in fact, socio-technical, such as setting generic setback distances or sound limits without attending to the local context.[8–10] Communities are frequently involved late in planning, if at all,[11–13] and benefits are not always shared in ways perceived as fair.[14–16] These patterns contribute to procedural and distributive injustice and to persistent mistrust.

Airborne wind energy is being developed against this backdrop. AWE systems use tethered kites or similar flying devices, either generating electricity onboard and transmitting it down a conductive tether or pulling a tether that drives a ground-based generator. They can operate at higher altitudes than conventional wind turbines, accessing stronger and more consistent winds. They require less material and smaller foundations and can be easier to transport and install, making them attractive for remote, island, or temporary applications.[17–21] Sector roadmaps also envision offshore AWE and the repowering of existing platforms in the longer term.[19,22]

These perceived advantages have fed a hopeful narrative: if AWE is less visually dominant and requires less material, it might avoid some of the social conflicts associated with large turbines.[23] However, the same features that make AWE promising also introduce new kinds of impacts and uncertainties. Kites fly in dynamic patterns through the airspace. They emit different types of sounds than rotating blades. They can carry aviation lights visible over long distances. They raise questions about airspace safety and the acceptability of deploying an emerging, relatively untested technology near where people live and work. Until recently, discussion of these issues in the AWE sector has been largely speculative and dominated by technical perspectives.[23] **Claims about higher social acceptance are often made without empirical backing. This creates a risk that development, deployment, and regulation are guided more by optimism than by evidence.**

The purpose of this report is to help close part of that gap. It synthesizes empirical research on community acceptance of airborne wind energy conducted within the context of a doctoral dissertation.[24] It translates the main findings into accessible language and draws out practical implications for developers, operators, and policymakers. Additionally, it outlines key research needs, acknowledging that the evidence base remains limited and that AWE is still an emerging technology.

2. How to make sense of and study community responses to AWE

2.1 What is meant by "community acceptance"

The term "acceptance" is widely used in energy research, but not always consistently.[25–28] Social scientists have distinguished different dimensions of acceptance, different levels at which it operates, and different ways of measuring it. For the purposes of this work, it is essential to clarify what is meant by community acceptance and how it relates to other forms of acceptance.

One influential framework distinguishes three dimensions: **socio-political acceptance** (support for technologies, policies, and actors at the level of public opinion and political debate), **community acceptance** (local responses to concrete projects and siting decisions), **and market acceptance** (willingness of investors, firms, and consumers to finance, buy, and use technologies).[29] Community acceptance is thus specifically concerned with how residents and local stakeholders respond to projects that affect their surroundings.

Another useful lens focuses on three broad types of factors that shape acceptance: the subject, the object, and the context.[30,31] The subject is the person or group whose acceptance is in question, with their attitudes, values, experiences, and social identities. The object is what is to be accepted: a technology in general, a concrete project, a policy, or an actor. The context encompasses both local and broader conditions that influence how subjects perceive the object, including institutional trust, past conflicts, media coverage, economic conditions, and land-use patterns. Acceptance is not a property of any one of these elements in isolation, but an outcome of their interaction.[32]

At the individual level, researchers have distinguished between attitudinal and behavioural dimensions of acceptance.[32] A person may express a favourable attitude toward a project yet not engage in supportive behaviour. In practice, community acceptance is often measured using self-reported attitudes, such as how acceptable or desirable a respondent finds a project or how strongly they support or oppose it.[33] This research adopts an attitudinal measure of community acceptance, while recognizing that attitudes do not automatically predict behaviour, partly because opponents are more likely to act on their negative attitudes than supporters are on their positive ones.[34–37] For this reason, the latter group is also referred to as the "silent majority".

The terms "acceptance" and "acceptability" are sometimes used interchangeably and occasionally distinguished.[32,38] For example, by reserving "acceptability" for normative assessments of whether a project should be accepted.[39,40] In this research, the focus is on empirically measurable attitudes as an indicator of community acceptance.

2.2 Five factors that help to explain community acceptance

Across the wealth of wind energy studies, five broad categories of factors consistently explain community acceptance. These factors have been summarized in the Integrated Acceptance Model (IAM; Figure 1), which explains acceptance of wind farms.[41]

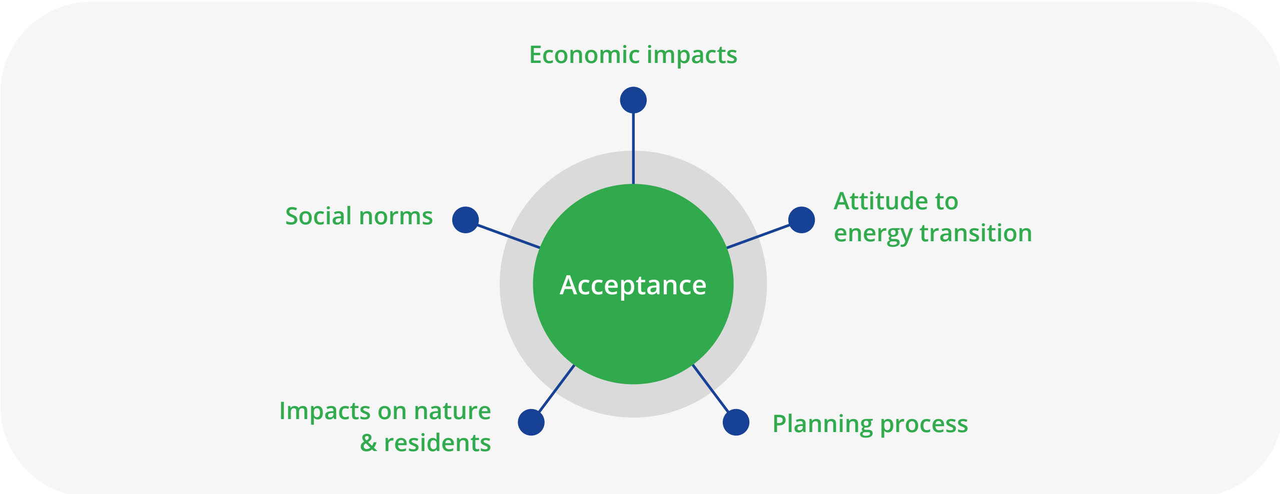

Figure 1. The Integrated Acceptance Model (IAM) encompasses five key predictors of community acceptance.

The categories are:

1) Perceived impacts of the renewable project on the local economy, including its effects on agriculture, property values, and tourism. Studies consistently show that when wind project benefits (e.g., jobs, local ownership, lower electricity costs) are seen as fairly distributed, residents are more accepting and report fewer negative impacts, whereas fears about losses to tourism or property values reduce acceptance.[14,34,42–50]

2) Attitudes toward the energy transition: People who support the transition in general are, on average, more likely to accept specific renewable projects because they view them as necessary and legitimate.[51,52]

3)Perceptions of the planning process, including transparency, fairness, information provision, and opportunities for participation. Perceived procedural fairness – that is, early and meaningful involvement, being taken seriously, having some influence, and experiencing developers as open and trustworthy – is consistently associated with higher acceptance and less negative impact perceptions. In contrast, engagement perceived as merely instrumental can be associated with lower acceptance.[12,36,45,49,53–59]

4) Perceived impacts of projects on residents and nature, notably sound and visual changes, as well as concerns about the effects on wildlife and landscapes. Perceived impacts, such as noise, shadow flicker, obstruction lights, landscape change, and risks to wildlife, are closely linked to annoyance and opposition.[14,15,33,45,60–67]

5) Social norms: what people believe others in their community think about the renewable project. Norms shape whether people support or oppose wind projects, as perceived social pressure and (often biased) beliefs about what "most others" think and do can drive both active opposition and silent conformity, making norms a powerful driver of local mobilization and conflict.[37,68–70]

The IAM has proven useful for explaining community responses to wind farms, but it was not designed with airborne systems in mind. Applying it to AWE helps examine whether the same clusters of factors are relevant and identify where the model may require adaptation. In the studies reported here, community acceptance of AWE is defined as an attitudinal measure: an individual's opinion of the AWE site, ranging from negative to positive. The IAM categories were measured with survey items tailored to AWE test sites, and all reported relationships are correlational rather than causal.

2.3 Where the evidence comes from and what it can't tell us

The evidence in this report comes from four types of studies:

1. **A comprehensive review of the academic literature on AWE.**[23] This review examined how AWE is framed, the claims made about its social and environmental impacts, and the extent to which social science insights are integrated into these assessments.

2. **A field study in Germany comparing residents' perceptions of a local AWE system with those of a nearby wind farm.**[71] Residents living near the AWE test site and the wind farm were surveyed about the perceived visual, acoustic, safety, and ecological impacts, as well as their perceptions of the transparency and fairness of the developer/operation, and their acceptance of each installation. This allowed a direct comparison of how an AWE system and wind turbines are experienced in the same local context.

3. **A study across two AWE test sites in Germany and Ireland applying the Integrated Acceptance Model (IAM; see previous section).**[72] Residents living near either AWE site were surveyed about their attitudes toward the energy transition, perceived impacts on residents and nature, perceptions of developer transparency and fairness, perceived social norms, and their acceptance of the local AWE project. Regression modelling was used to identify which of these factors significantly explained acceptance.

4. **A laboratory listening experiment investigated the acoustic and individual factors that influence noise annoyance for AWE systems.**[73] Field recordings of different AWE systems, including soft-wing and fixed-wing kites with varied acoustic characteristics, were presented to participants under controlled conditions (Figure 2). Participants rated their annoyance, and data were collected on psychoacoustic metrics of the sounds (e.g., loudness, sharpness, and tonality) and on individual characteristics (noise sensitivity, age, and familiarity with AWE).

Figure 2. A participant in the listening laboratory. Image credits: Roberto Merino Martinez.

The research design is subject to several limitations:

- The field and survey studies focused on specific test sites and particular AWE designs, especially soft-wing ground-generation systems, limiting the generalizability of the results to other AWE concepts.
- The technology was still in its early, experimental stage at the time of data collection, with small-scale, temporary sites that did not feed significant amounts of electricity into the grid. As a result, some factors that might become important during commercial deployment, such as long-term economic benefits or cumulative landscape effects, could not be fully captured.
- Sample sizes, although appropriate for the methods used, were not sufficiently large to represent all possible community perspectives or detect small effects.
- The studies focus on community-level responses and do not directly address socio-political or market acceptance, although these dimensions are discussed conceptually.

These limitations underline the need for cautious interpretation and for further research. At the same time, they do not undermine the value of the findings. **The studies provide the first systematic empirical insight into how communities respond to AWE and establish a baseline against which future work can be compared.**

3. What the first studies tell us about communities and AWE

The empirical work yields a coherent set of findings when considered together:

The literature review shows that sector narratives about social acceptance are ahead of the evidence. AWE is often presented as inherently more acceptable than wind turbines because it is assumed to be less visible, quieter, and less harmful to wildlife. Safety and siting decisions were mentioned as potential social constraints. However, these assertions lacked empirical support. In general, empirical research to substantiate these claims about AWE acceptance has been absent, and possible social and environmental risks have received relatively little attention.

The review also showed that AWE research had been dominated by technical work, with almost no interdisciplinary collaboration beyond the technical domains until very recently. This creates a risk that design, siting, and policy decisions are made based on assumptions rather than data, and that potential points of conflict are overlooked until they become acute.

The German field study challenges the idea that residents are more readily accepting of AWE than wind turbines. People living near the AWE system perceived it as less visually intrusive than the nearby wind farm, which supports the view that lower visual impact is a real advantage in certain settings (Figure 2). However, the study reveals that the dynamic, rapid movement of the airborne component can attract attention in a way that slow-rotating blades do not. In tranquil rural landscapes, this unsteady motion can be perceived as “restless” or chaotic.

Moreover, people rated the AWE system similarly to the wind farm in terms of sound, safety, and ecological impacts. Yet, the nature of safety perceptions for AWE differed fundamentally from those of conventional wind. People intuitively understand the risks of blades falling or a tower catching fire, but the risks and consequences of a tether snapping or a kite crashing are harder to gauge. For both the AWE system and the wind farm, residents who felt more negatively affected by the installations in their daily lives were less willing to accept them. Perceptions of the developer’s transparency and fairness were statistically associated with higher acceptance and lower noise annoyance for both technologies. The field results therefore suggest that AWE is evaluated through a similar lens as wind turbines, and that lower visibility alone is not enough to secure local support.

The study in Germany and Ireland applies the Integrated Acceptance Model (IAM) to AWE test sites (Figure 3), confirming the central roles of perceived impacts, transparency, and fairness in AWE acceptance. Impacts on residents, such as noise annoyance, visual changes, and annoyance from aviation lights, predicted lower acceptance. Perceived transparency and fairness of the developer and site operation explained higher acceptance. In contrast, attitudes toward the energy transition, perceived economic effects, and social norms did not significantly predict acceptance in this context. The likely explanation is not that these factors are irrelevant to AWE in principle, but rather that they did not yet play a significant role at the early test sites.

In Germany, participants were asked about hypothetical economic effects of future AWE projects, while in Ireland, they assessed the limited and temporary economic impacts of the test site. In neither case were there substantial concrete local benefits to evaluate (i.e., economic effects). AWE was also not yet contributing meaningfully to renewable energy targets, making it difficult for laypeople to position it within their broader views on the energy transition (i.e., energy transition attitudes).

The absence of large-scale public debate weakened social norms: the German site did not undergo a formal planning process comparable to that of a wind farm, and the Irish site received limited media coverage. Under these conditions, residents had fewer cues about what others thought, and normative expectations (i.e., social norms) played a smaller role. These patterns suggest that as AWE projects become larger, commercial, and more integrated into planning regulations, economic perceptions, energy transition attitudes, and social norms may become increasingly important predictors of acceptance. The IAM remains a useful framework, but its application to AWE at this stage captures only a subset of its predictors.

Figure 3. Residents living within 5 km of either site rated their perceptions of the AWE test sites in Germany (left) and Ireland (right). Image credits: SkySails Power GmbH/Kitepower B.V.

The listening experiment deepens the analysis of noise annoyance. It shows that the investigated fixed-wing kites tend to be perceived as more annoying than the soft-wing kites, primarily because of their sharper and more tonal sound. Psychoacoustic parameters such as sharpness were predictors of annoyance. Individual noise sensitivity was associated with higher annoyance, and older participants were less bothered by tonal sounds than younger ones, suggesting age-related differences in how people perceive and interpret acoustic features. Familiarity with AWE also mattered: participants who were already familiar with the technology reported less annoyance when listening to recordings that were subjectively louder than those with no prior knowledge. These findings align with research on drones that has shown that sharpness, loudness, and tonality can help explain noise annoyance.[74–77] **Taken together, these studies show that community responses to AWE share many features with responses to wind farms.** Perceived impacts on residents and nature, especially sound, visual change, and aviation lights, are central correlates of acceptance. Perceived transparency and fairness of developers and processes are equally important. Noise annoyance is shaped by both measurable sound characteristics (i.e., sharpness, tonality, loudness) and subjective, contextual factors (i.e., noise sensitivity, familiarity, age, perceived project impacts). Where AWE appears to diverge is likely a consequence of its current developmental stage: some predictors that matter for mature wind turbines are not yet salient for small, temporary, and experimental AWE test sites.

Three overarching conclusions follow.

1. **Optimism about AWE's acceptance must be balanced by empiricism.** High hopes and positive narratives are understandable and, in some ways, necessary to mobilize investment in a high-risk, long-horizon technology. However, if these narratives are not grounded in data, they can mislead design choices, policy-making, and public communication. The present research demonstrates that some optimistic assumptions about AWE's social advantages over wind turbines are premature.

2. **Social and technical dimensions of AWE development need to be integrated rather than treated separately.** The sector's focus has understandably been on solving technical challenges and improving performance. Yet the evidence shows that acceptance is not a secondary consequence of getting the technology "right"; it is an equally critical dimension that must shape decisions about system design, siting, and operations. Effective mitigation strategies for noise and other impacts require both technical know-how and social insight into how people experience and interpret those impacts.

3. **Subjective and contextual factors play a decisive role in community acceptance.** Objective impacts, such as sound levels or visibility, matter, but they do not tell the whole story. Individual characteristics, such as noise sensitivity and familiarity with AWE, as well as contextual factors, including perceived fairness in planning and the quality of relationships with developers and authorities, shape how people respond to AWE. This means that acceptance cannot be reduced to a technical problem to be solved by meeting generic thresholds. It is a relational and contextual issue that requires attention to the specific communities and places in which AWE is deployed.

Figure 4. Airborne wind energy should be situated within broader renewable energy plans. Image credits: SkySails Power GmbH.

4. What this means if you plan or operate AWE projects

For developers and operators, the findings suggest that acceptance should be treated as a design and operational consideration, rather than an afterthought. Technical performance, cost, and safety remain critical, but they are not sufficient in themselves. Projects that neglect community concerns or address them only superficially burden residents and risk delays, conflict, and reputational damage that can spill over to the wider sector.

4.1 Designing projects and technology with community interests in mind

Noise, visual impacts, and aviation lights must be addressed systematically in design and operation. The listening experiment revealed that psychoacoustic properties, such as sharpness, influence annoyance, and that fixed-wing designs may be more challenging in this respect than soft-wing systems. **Developers should therefore invest in design modifications to reduce sharpness and tonality where possible**, for example, by optimizing on-board turbines and adjusting kite design and materials. Operational strategies such as changing flight speed, height, or paths at sensitive times of day, and avoiding low-altitude passes over noise-sensitive areas, should be considered.

In the German field study, residents sometimes described the airborne component as visually "restless", even when they judged the overall system as less intrusive than nearby turbines. **Developers should therefore assess not only how far the system is visible, but how its motion interacts with local vistas and routines**, for example, by avoiding prominent view corridors or sensitive times for visually dominant flight patterns (e.g., funerals when near a graveyard).

Aviation lighting should be designed and operated to minimize unnecessary disturbance. Potentially utilizing demand-based systems that activate only when aircraft are nearby, provided regulations and technology permit. Test sites, in particular, should be treated as places to experiment with better social and technical solutions, with systematic documentation of what works and what does not from a community perspective.

Figure 5. Image credits: EnerKíte GmbH/Philipp Arnoldt.

4.2 Implementing inclusive engagement and co-production

Beyond mitigating impacts, fair and inclusive processes are central for community acceptance. The research confirms that perceptions of developer transparency and fairness are strongly linked to acceptance and noise annoyance. **Developers should apply best practices from participatory planning in the test phase already, even when formal public engagement is not legally required**[1]. Waiting until commercial deployment to "take engagement seriously" risks locking in mistrust and missing a key learning opportunity.

Three elements are critical for fair engagement: transparency, trust, and influence.

Transparency means providing clear, accessible, and honest information about the project's purpose, the technology's state of development (given its novelty), and potential impacts. This requires going beyond promotional material and technical jargon, acknowledging uncertainties, and explaining how impacts will be monitored and managed. It also means making documents and data easy to access, for example, through a local information point (e.g., municipality), a well-maintained project website, and regular updates (e.g., newsletter).

Given AWE's unfamiliar risk profile, the topic of safety should be adequately addressed. Residents in the German field study found it harder to judge the likelihood and consequences of airborne risks, such as a tether snapping or a kite crashing, than they did for more familiar turbine failures. Developers should therefore present clear and credible information on safety, including safety guards, worst-case scenarios, emergency procedures, and how these have been tested and audited by independent bodies. **Creating opportunities for direct experience can also be valuable.** Site visits, demonstration days, and simple explanatory materials about how the system sounds and behaves can help residents develop realistic expectations and reduce uncertainty.

Furthermore, developers must rethink how they present the visual impact of AWE to communities. Traditional photomontages used for wind farms are static, and they do not accurately represent the motion of an AWE system. For AWE, developers could use video simulations and Virtual Reality (VR) tools during public consultations.

[1] More elaborate guidelines on community engagement for AWE test sites can be found in the report "Securing local support for airborne wind energy projects - A guide for project developers." [78]

Trust is built when residents feel that the developer takes their concerns seriously rather than treating engagement as a box-ticking exercise to secure approval. If people sense that participation activities are primarily meant to defuse opposition, engagement can worsen attitudes rather than improve them. **Developers should therefore invest in relationship-building measures that go beyond regulatory requirements**, such as appointing an impartial community liaison who is well-known locally, regularly present on the ground, and empowered to feed concerns back into the decision-making process. Consistency of personnel over time, responsiveness to questions, and visible follow-up on issues raised also help to build trust.

Early-stage AWE projects are also characterised by frequent testing and adjustment. Irregular flight schedules, atypical manoeuvres, and occasional downtime can heighten uncertainty among nearby residents. **Developers should communicate test schedules and expected operational changes in advance where possible and explain unusual events and visible changes in a timely way, so that "experimentation" does not translate into worry or frustration**.

Influence means that residents have real opportunities to shape important aspects of the project, rather than merely providing comments on decisions that have already been made. This can include involving local representatives in the selection of micro-siting options within a wider zone, jointly defining operational constraints (e.g., on night-time operation), and co-designing monitoring programs and/or reporting practices. **Developers should treat local knowledge – about landscape use, wildlife, tourism dynamics, and everyday routines – as a resource that can improve project outcomes**, even when this input does not initially align exactly with economic or strategic preferences.

Conflict and criticism should not be viewed simply as risks to be minimized. Open disagreement can reveal blind spots in project design and point to better alternatives if taken seriously. Meaningful exchanges between developers, planners, scientists, and local communities can improve both individual projects and the broader AWE development. In this sense, social conflict can be a driver for more socially responsible technology development rather than a sign that engagement has "failed".

Inclusive participation should also extend beyond the immediate host community. For AWE, relevant stakeholders include environmental organizations, aviation and safety authorities, regulatory agencies, financial institutions, utility companies, research institutions, and regional and national authorities. Involving these actors early and integrating their input visibly helps anticipate and proactively address challenges and bottlenecks.

A recent research project explored how such multi-actor perspectives can be integrated into regional planning approaches by allowing a range of relevant stakeholders, including residents, to design their preferred renewable energy landscape in a virtual environment.[79] The inclusion of AWE in this digital planning tool illustrates how the technology can be positioned within broader spatial, economic, and societal trade-offs at an early stage, before large-scale deployment.

4.3 Designing benefit-sharing and compensation that fit local contexts

Developers should think about benefit-sharing and local value creation from the outset, even at test sites. Although economic impacts did not predict acceptance in the studied cases, this probably reflects the test sites' limited scale and temporary nature rather than a general irrelevance of benefits. When AWE moves toward commercial deployment, issues of who gains and who bears the burdens will most likely become more salient.

Evidence from wind projects shows that such schemes can increase acceptance and reduce perceived harms when they are seen as fair and meaningful. Many wind developers now offer monetary or in-kind benefits to host communities, and AWE developers are likely to follow a similar path. Benefit-sharing can include local jobs, landowner payments, community ownership or financial participation schemes, reduced electricity costs for residents, and landscape or environmental enhancement measures. However, they are not a universal remedy and can backfire if perceived as inappropriate or as attempts to "buy" consent.

Effective benefit-sharing starts with a careful identification of who is actually affected by the project and in what ways. Developers should identify stakeholders who live near the site, those who experience direct negative impacts (such as noise or visual intrusion), and those whose livelihoods may be affected, for example, through changes in tourism or land use. They then need to understand the priorities, concerns, and risk tolerance of these groups. For example, communities with limited financial resources may be unable or unwilling to adopt ownership models that require upfront investment, and they may prioritize community funds, infrastructure improvements, or training/education opportunities.

AWE's smaller ground footprint can make co-use with agriculture and other land uses more feasible, but moving tethers and safety buffers can still affect how land is worked. Benefit-sharing and local value creation should therefore be discussed alongside concrete land-use arrangements, for example, access, the timing of operations, and compensation for any restrictions on farming practices.

Once this groundwork has been done, compensation and benefit-sharing mechanisms can be tailored to local conditions. This may mean combining several instruments rather than relying on a single model, and adjusting schemes over time as projects move from test operation to long-term deployment. Developers should be transparent about the rationale, scale, and distribution of benefits, and should involve local representatives in the design and oversight of schemes. Importantly, benefit-sharing should be embedded in a broader relationship of trust and engagement; it cannot compensate for a deficient process or unmanaged project impacts.

4.4 Building sector-wide learning and standards

Companies in the AWE sector should support the development of a robust evidence base and good practice standards. This includes collaborating with researchers by granting access to sites and data, using standardized survey and acoustic methods that facilitate comparison across projects, and publishing results transparently, including instances where impacts or community responses are less positive than anticipated. Test sites can be framed explicitly as learning spaces, not only for engineers and researchers but also for nearby communities and authorities.

It also includes investing in staff training on engagement and conflict management, as well as integrating acceptance considerations into internal decision-making processes. For example, by treating them as formal project risks alongside technical and financial ones. Industry associations can play a crucial role by coordinating voluntary codes of conduct for engagement, benefit-sharing, and monitoring, and by facilitating the exchange of experiences among developers. This will help the sector move from ad hoc responses to social issues to more systematic, evidence-informed practices.

Figure 6. Survey invitations are being prepared for sending. Image credits: Helena Schmidt.

5. What this means for rules, permits, and planning frameworks

Policymakers and regulators shape the conditions under which AWE is developed, tested, and deployed. They have a responsibility to ensure that the technology can contribute to climate and energy goals while protecting residents, nature, and public interests. **The findings from this research highlight several areas where governance needs to adapt to AWE's specific characteristics and early-stage status.**

1) The need to better integrate acceptance considerations into permitting and siting rules for AWE.

Where AWE projects are assessed under existing wind turbine regulations, there is a risk of both under- and over-regulation. On the one hand, generic thresholds or setback rules may not capture the specific sound and operational characteristics of different AWE designs. On the other hand, applying rules designed for tall, static turbines to small, dynamic kites may be unnecessarily restrictive in some respects. **Regulators should therefore develop AWE-specific immission criteria that take into account not only sound pressure levels but also psychoacoustic qualities known to affect annoyance, as well as the visibility and operational patterns of moving kites and aviation lights.** These criteria should be informed by empirical studies rather than assumed to be similar to wind turbines, and should be designed to be adaptive as more evidence becomes available.

2) The need for clear rules on airspace integration.

AWE systems operate in low-altitude airspace and interact with existing aviation uses, including general aviation, helicopters, and unmanned aerial vehicles (UAVs). **Dedicated regulations are necessary to clarify how AWE is integrated into airspace management and to minimize conflicts and safety risks.** This includes defining permitted flight volumes, establishing procedures for emergencies, and requiring transponders or other signalling technologies where appropriate. Residents' safety concerns will not be addressed by assurances alone; credible and enforceable rules must back them, including clear responsibilities for incident reporting and communication.

3) Regulators should set minimum requirements for community engagement and, where appropriate, benefit-sharing.

The research indicates that perceptions of fairness and transparency are crucial. **Policy can support good practice by specifying when and how local communities must be informed and consulted, what information must be provided, and how developers should document and respond to concerns.** Guidelines can recommend or require that engagement begin early, utilize various formats, and demonstrate how input influences decisions. For AWE, this can include specific expectations for realistically showing motion and sound, for example, through video, animations, or virtual reality tools, rather than only static images. **For projects beyond the test stage, policymakers may also consider requiring some form of local benefit-sharing, such as community funds or participation schemes, while leaving room for context-specific design.**

4) Evidence-based regulation depends on data. Policymakers and regulators should ensure that AWE projects are subject to appropriate monitoring and reporting obligations, covering sound, visual, and other relevant impacts, as well as safety incidents.

Data should be collected and reported using standardized protocols that allow comparison across sites and systems. Where feasible, this should include both physical indicators (e.g., sound levels, psychoacoustic metrics) and social indicators (e.g., survey-based measures of annoyance and acceptance). Where possible, data should be made available to independent researchers and the public, subject to considerations of privacy and safety. This supports learning, trust, and adaptive regulation.

5) AWE should be integrated coherently into broader energy, environmental, and regional policies rather than treated in isolation.

This involves situating AWE within national and regional energy planning, clarifying its contribution to renewable energy targets, and ensuring that deployment aligns with biodiversity and land-use objectives. It also means recognizing the potential role of AWE in rural and regional development strategies and aligning policies accordingly. Because AWE spans energy, aviation, and environmental regulation, coordination among responsible authorities is essential, particularly at test sites that can serve as “regulatory sandboxes” for learning. Coherence reduces the risk that communities experience AWE projects as disconnected or opportunistic and supports a more predictable and transparent planning environment.

Figure 7. Test sites, like the one depicted, should be used as regulatory sandboxes for learning. Image credits: Kitepower B.V.

6. What we still need to discover

The research underlying this report identifies several priorities for further study to support informed decisions and the socially robust development of AWE. The priorities include:

1. **To deepen our understanding of how different acceptance factors interact over time.** Literature on wind turbines indicates that economic effects, attitudes toward the energy transition, perceived impacts, perceptions of the planning process, and social norms collectively influence project acceptance. The AWE studies suggest that some of these factors are already significant to this new technology, while others are not yet salient at the early test sites. Future research should investigate how these relationships evolve as projects scale up, transition from temporary tests to long-term operations, and become integrated into formal planning and regulatory frameworks. Longitudinal studies following communities through different project phases can help capture dynamic changes in acceptance and identify critical moments for intervention, including when unfamiliar aspects such as AWE's motion patterns, airspace use, and risk profile become normalised or contested.

2. **To broaden the range of systems, contexts, and stakeholders studied.** The empirical work to date has focused on specific soft-wing ground-generation systems in Germany and Ireland. Other AWE concepts, including fixed-wing systems and larger multi-unit sites, may raise different issues. Acceptance should be studied across diverse geographical, cultural, and socio-economic settings, rather than assuming that findings from early sites in the Global North will apply elsewhere. It will also be important to include stakeholders beyond residents and local authorities, such as farmers, Indigenous communities, environmental NGOs, aviation and drone operators, and industrial users, and to study the institutional legitimacy of AWE among policymakers, regulators, and financiers.

3. **To use robust methods and data. Energy acceptance research has often relied on one-off surveys in individual case studies, which makes comparison and synthesis difficult.** For AWE, building a stronger evidence base will require more coordinated approaches, including the use of standardized survey instruments, shared acoustic and visual indicators, transparent reporting, and open data where possible. Mixed-methods designs that combine qualitative and quantitative approaches can capture both patterns and meanings. Interdisciplinary collaboration, such as between social scientists, acousticians, spatial planners, and engineers, is essential for linking measured impacts to perceived impacts and for designing and evaluating mitigation measures. Over time, this work can feed into shared databases and guidelines.

4. **To adapt research to technological and deployment changes.** As AWE technology matures, noise characteristics, visual profiles, flight patterns, and operational regimes are likely to change. The social implications of early prototypes do not fully capture those of commercial systems. Researchers will need to collaborate with industry and regulators to anticipate emerging issues, keep measurements up to date, and focus on aspects most relevant to residents as deployment scales up. This includes monitoring not only regular operations but also unusual events, such as emergency procedures and new manoeuvres, which may influence perceptions.

7. Key takeaways

Airborne wind energy is at an important stage. The sector has demonstrated core technical feasibility and is developing toward larger and more automated systems. At the same time, it is still shaping its identity, its relationship to existing energy infrastructures, and its interaction with communities and institutions. **Decisions taken now about how to design, site, regulate, and communicate AWE will influence not only individual projects, but also the technology's long-term social license to operate.**

This report has drawn on the first empirical research on community acceptance of AWE to outline what is currently known and what this implies for practice and policy. **The evidence does not support simple claims that AWE will automatically be more acceptable than wind turbines. Instead, it shows that AWE is subject to similar patterns of acceptance, rooted in perceived impacts, fairness, trust, and context, with additional nuances related to its developmental stage and specific acoustic and operational features.**

Three central messages should guide action.

1. **Optimism about AWE's potential must be balanced with empirical scrutiny**, so that decisions and narratives are grounded in how people actually experience the technology rather than how we hope they will.
2. **The social and technical dimensions of AWE are inseparable**; both social insights and engineering logic must inform the mitigation of impacts and design of operations.
3. **Community acceptance is shaped by subjective perceptions and contextual conditions as much as by measurable impacts**, which means that relationships, procedures, and institutional frameworks are also important.

For developers and operators, this means integrating community acceptance considerations into core business and design decisions, engaging communities early and meaningfully, and contributing to a shared evidence base. For policymakers and regulators, it means developing AWE-specific, yet proportionate, rules on emissions and airspace, setting clear expectations for engagement and benefit-sharing, and ensuring robust data informs decisions. For researchers and funders, it means building on this initial work with broader, deeper, and more collaborative studies that track AWE as it evolves.

In the coming years, Work Package 4 of the IEA Wind TCP Task 48 on social acceptance will provide an important platform to build on this research. WP4's programme explicitly covers framing, narratives and public imaginaries of AWE; socio-political and institutional acceptance among policymakers, financiers and regulators; community perceptions and local acceptance at different project stages; participation, benefit-sharing and co-creation models suited to AWE; comparative acceptance dynamics across technologies and regions (including island states and parts of the Global South); as well as sound emissions, perceived noise and environmental impacts and how these shape public responses.

The planned outputs – such as an AWE narrative and communication toolkit, an institutional legitimacy roadmap, a local acceptance compendium and participation model catalogue, and shared databases on social and environmental studies – will translate the patterns identified in this report into practical guidance and shared datasets for industry, authorities, and researchers.

Handled well, AWE could become a useful and accepted component of a just energy transition, contributing to climate goals while respecting the needs and rights of communities and ecosystems. Handled poorly, it risks encountering the same resistance and mistrust that have hampered other technologies. The outcome depends on the decisions taken now by industry, policymakers, and the wider research community.

8. Sources and further reading

1. Geels, F. W., Sovacool, B. K., Schwanen, T., & Sorrell, S. (2017). The sociotechnical dynamics of lowcarbon transitions. *Joule*, *1*(3), 463–479. https://doi.org/10.1016/j.joule.2017.09.018
2. Kirkegaard, J. K., Rudolph, D. P., Nyborg, S., Solman, H., Gill, E., Cronin, T., & Hallisey, M. (2023). Tackling grand challenges in wind energy through a socio-technical perspective. *Nature Energy*, *8*(7), 655–664. https://doi.org/10.1038/s41560-023-01266-z
3. Susskind, L., Chun, J., Gant, A., Hodgkins, C., Cohen, J., & Lohmar, S. (2022). Sources of opposition to renewable energy projects in the United States. *Energy Policy*, *165*, 112922. https://doi.org/10.1016/j.enpol.2022.112922
4. Temper, L., Avila, S., Bene, D. Del, Gobby, J., Kosoy, N., Billon, P. Le, Martinez-Alier, J., Perkins, P., Roy, B., Scheidel, A., & Walter, M. (2020). Movements shaping climate futures: A systematic mapping of protests against fossil fuel and low-carbon energy projects. *Environmental Research Letters*, *15*(12), 123004. https://doi.org/10.1088/1748-9326/abc197
5. Burningham, K., Barnett, J., & Walker, G. (2015). An array of deficits: Unpacking NIMBY discourses in wind energy developers' conceptualizations of their local opponents. *Society & Natural Resources*, *28*(3), 246–260. https://doi.org/10.1080/08941920.2014.933923
6. Devine-Wright, P. (2005). Beyond NIMBYism: Towards an integrated framework for understanding public perceptions of wind energy. *Wind Energy*, *8*(2), 125–139. https://doi.org/10.1002/we.124
7. Wolsink, M. (2007). Wind power implementation: The nature of public attitudes: Equity and fairness instead of 'backyard motives.' *Renewable and Sustainable Energy Reviews*, *11*(6), 1188–1207. https://doi.org/10.1016/j.rser.2005.10.005
8. Kirkegaard, J. K., Cronin, T. H., Nyborg, S., & Frantzen, D. N. (2025). The multiple understandings of wind turbine noise: reviewing scientific attempts at handling uncertainty. *Wind Energy Science*, *10*(5), 907–924. https://doi.org/10.5194/wes-10-907-2025
9. Rudolph, M., Vollmer, C., & Plappert, M.-L. (2019). *Technische Maßnahmen zur Minderung akzeptanzhemmender Faktoren der Windenergienutzung an Land*. https://www.umweltbundesamt.de/sites/default/files/medien/376/publikationen/190611_uba_hg_windenergie_bf.pdf
10. Taylor, J., & Klenk, N. (2019). The politics of evidence: Conflicting social commitments and environmental priorities in the debate over wind energy and public health. *Energy Research & Social Science*, *47*, 102–112. https://doi.org/10.1016/j.erss.2018.09.001
11. Clausen, L. T., Rudolph, D., & Nyborg, S. (2021). The good process or the great illusion? A spatial perspective on public participation in Danish municipal wind turbine planning. *Journal of Environmental Policy & Planning*, *23*(6), 732–751. https://doi.org/10.1080/1523908x.2021.1910017
12. Elmallah, S., & Rand, J. (2022). "After the leases are signed, it's a done deal": Exploring procedural injustices for utility-scale wind energy planning in the United States. *Energy Research & Social Science*, *89*, 102549. https://doi.org/10.1016/j.erss.2022.102549
13. Jami, A. A., & Walsh, P. R. (2017). From consultation to collaboration: A participatory framework for positive community engagement with wind energy projects in Ontario, Canada. *Energy Research & Social Science*, *27*, 14–24. https://doi.org/10.1016/j.erss.2017.02.007
14. Baxter, J., Morzaria, R., & Hirsch, R. (2013). A case-control study of support/opposition to wind turbines: Perceptions of health risk, economic benefits, and community conflict. *Energy Policy*, *61*, 931–943. https://doi.org/10.1016/j.enpol.2013.06.050
15. Brannstrom, C., Leite, N. S., Lavoie, A., & Gorayeb, A. (2022). What explains the community acceptance of wind energy? Exploring benefits, consultation, and livelihoods in coastal Brazil. *Energy Research & Social Science*, *83*, 102344. https://doi.org/10.1016/j.erss.2021.102344
16. Leer Jørgensen, M., Anker, H. T., & Lassen, J. (2020). Distributive fairness and local acceptance of wind turbines: The role of compensation schemes. *Energy Policy*, *138*, 111294. https://doi.org/10.1016/j.enpol.2020.111294
17. Cherubini, A., Papini, A., Vertechy, R., & Fontana, M. (2015). Airborne wind energy systems: A review of the technologies. *Renewable and Sustainable Energy Reviews*, *51*, 1461–1476. https://doi.org/10.1016/j.rser.2015.07.053
18. Luchsinger, R., Aregger, D., Bezard, F., Costa, D., Galliot, C., Gohl, F., Heilmann, J., Hesse, H., Houle, C., Wood, T. A., & Smith, R. S. (2018). Pumping cycle kite power with twings. In R. Schmehl (Ed.), *Airborne Wind Energy* (24). Springer. https://doi.org/10.1007/978-981-10-1947-0_24

19. BVG Associates. (2022). *Getting airborne - the need to realise the benefits of airborne wind energy for net zero/white paper for Airborne Wind Europe*. https://doi.org/10.5281/zenodo.7809185
20. van Hagen, L., Petrick, K., Wilhelm, S., & Schmehl, R. (2023). Life-cycle assessment of a multi-megawatt airborne wind energy system. *Energies*, *16*(4), 1750. https://doi.org/10.3390/en16041750
21. Wilhelm, S. (2018). Life cycle assessment of electricity production from airborne wind energy. In R. Schmehl (Ed.), *Airborne wind energy* (pp. 727–750). Springer. https://doi.org/10.1007/978-981-10-1947-0_30
22. IRENA. (2021). *Offshore renewables: An action agenda for deployment*.
23. Schmidt, H., de Vries, G., Renes, R. J., & Schmehl, R. (2022). The social acceptance of airborne wind energy: A literature review. *Energies*, *15*(4), 1384. https://doi.org/10.3390/en15041384
24. Schmidt, H. (2025). *Community acceptance of airborne wind energy: Is the sky the limit?* [Doctoral Dissertation]. TU Delft.
25. Batel, S., Devine-Wright, P., & Tangeland, T. (2013). Social acceptance of low carbon energy and associated infrastructures: A critical discussion. *Energy Policy*, *58*, 1–5. https://doi.org/10.1016/j.enpol.2013.03.018
26. 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. *Land Use Policy*, *76*, 235–245. https://doi.org/10.1016/j.landusepol.2018.05.016
27. Ellis, G., & Ferraro, G. (2016). *The social acceptance of wind energy: Where we stand and the path ahead*. https://doi.org/10.2789/696070
28. Wolsink, M. (2019). Social acceptance, lost objects, and obsession with the 'public'—The pressing need for enhanced conceptual and methodological rigor. *Energy Research & Social Science*, *48*, 269–276. https://doi.org/10.1016/j.erss.2018.12.006
29. Wüstenhagen, R., Wolsink, M., & Bürer, M. J. (2007). Social acceptance of renewable energy innovation: An introduction to the concept. *Energy Policy*, *35*(5), 2683–2691. https://doi.org/10.1016/j.enpol.2006.12.001
30. Lucke, D. (1995). *Akzeptanz: Legitimität in der „Abstimmungsgesellschaft"*. Leske + Budrich.
31. Wolsink, M. (2013). Wind power: Basic challenge concerning social acceptance. In M. Kaltschmitt, N. J. Themelis, L. Y. Bronicki, L. Söder, & L. A. Vega (Eds.), *Renewable Energy Systems* (pp. 1785–1822). Springer. http://hdl.handle.net/11245/2.117393http://hdl.handle.net/11245/1.378451
32. Schäfer, M., & Keppler, D. (2013). *Modelle der technikorientierten Akzeptanzforschung* (34). https://www.researchgate.net/publication/271511660_Modelle_der_technikorientierten_Akzeptanzforschung_-_Uberblick_und_Reflexion_am_Beispiel_eines_Forschungsprojekts_zur_Implementierung_innovativer_technischer_Energieeffizienz-Massnahmen
33. Rand, J., & Hoen, B. (2017). 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
34. Firestone, J., Hoen, B., Rand, J., Elliott, D., Hübner, G., & Pohl, J. (2018). Reconsidering barriers to wind power projects: Community engagement, developer transparency and place. *Journal of Environmental Policy & Planning*, *20*(3), 370–386. https://doi.org/10.1080/1523908x.2017.1418656
35. Hübner, G., Pohl, J., Warode, J., Gotchev, B., Ohlhorst, D., Krug, M., Salecki, S., & Peters, W. (2020). *Akzeptanzfördernde Faktoren erneuerbarer Energien*. https://www.bfn.de/publikationen/bfn-schriften/bfn-schriften-551-akzeptanzfoerdernde-faktoren-erneuerbarer-energien
36. Liu, L., Perlaviciute, G., & Squintani, L. (2022). Opposing out loud versus supporting in silence: Who wants to participate in decision-making about energy projects? *Environmental Research Letters*, *17*(11). https://doi.org/10.1088/1748-9326/AC9F24
37. Sokoloski, R., Markowitz, E. M., & Bidwell, D. (2018). Public estimates of support for offshore wind energy: False consensus, pluralistic ignorance, and partisan effects. *Energy Policy*, *112*, 45–55. https://doi.org/10.1016/j.enpol.2017.10.005
38. Moesker, K., Pesch, U., & Doorn, N. (2024). Making sense of acceptance and acceptability: Mapping concept use in energy technologies research. *Energy Research & Social Science*, *115*, 103654. https://doi.org/10.1016/j.erss.2024.103654
39. Bertsch, V., Hall, M., Weinhardt, C., & Fichtner, W. (2016). Public acceptance and preferences related to renewable energy and grid expansion policy: Empirical insights for Germany. *Energy*, *114*, 465–477. https://doi.org/10.1016/j.energy.2016.08.022
40. Taebi, B. (2016). Bridging the gap between social acceptance and ethical acceptability. *Risk Analysis*, *37*(10). https://doi.org/10.1111/risa.12734

41. Hübner, G., Leschinger, V., Müller, F. J. Y., & Pohl, J. (2023). Broadening the social acceptance of wind energy – An Integrated Acceptance Model. *Energy Policy*, *173*, 113360. https://doi.org/10.1016/j.enpol.2022.113360
42. Arezes, P. M., Bernardo, C. A., Ribeiro, E., & Dias, H. (2014). Implications of wind power generation: Exposure to wind turbine noise. *Procedia - Social and Behavioral Sciences*, *109*, 390–395. https://doi.org/10.1016/j.sbspro.2013.12.478
43. Firestone, J., Hirt, C., Bidwell, D., Gardner, M., & Dwyer, J. (2020). Faring well in offshore wind power siting? Trust, engagement and process fairness in the United States. *Energy Research & Social Science*, *62*, 101393. https://doi.org/10.1016/j.erss.2019.101393
44. Health Canada. (2014). *Wind turbine noise and health study: Summary of results*. https://www.canada.ca/en/health-canada/services/health-risks-safety/radiation/everyday-things-emit-radiation/wind-turbine-noise/wind-turbine-noise-health-study-summary-results.html
45. Hoen, B., Firestone, J., Rand, J., Elliot, D., Hübner, G., Pohl, J., Wiser, R., Lantz, E., Haac, T. R., & Kaliski, K. (2019). Attitudes of U.S. wind turbine neighbors: Analysis of a nationwide survey. *Energy Policy*, *134*, 110981. https://doi.org/10.1016/j.enpol.2019.110981
46. Hogan, J. L. (2024). Why does community ownership foster greater acceptance of renewable projects? Investigating energy justice explanations. *Local Environment*, *29*(9), 1221–1243. https://doi.org/10.1080/13549839.2024.2360716
47. Leiren, M. D., Aakre, S., Linnerud, K., Julsrud, T. E., Di Nucci, M. R., & Krug, M. (2020). Community acceptance of wind energy developments: Experience from wind energy scarce regions in Europe. *Sustainability*, *12*(5), 1754. https://doi.org/10.3390/su12051754
48. 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: Economy and Space*, *46*(3), 730–745. https://doi.org/10.1068/a130004p
49. Mills, S. B., Bessette, D., & Smith, H. (2019). Exploring landowners' post-construction changes in perceptions of wind energy in Michigan. *Land Use Policy*, *82*, 754–762. https://doi.org/10.1016/j.landusepol.2019.01.010
50. Ólafsdóttir, R., & Sæþórsdóttir, A. D. (2019). Wind farms in the Icelandic highlands: Attitudes of local residents and tourism service providers. *Land Use Policy*, *88*, 104173. https://doi.org/10.1016/j.landusepol.2019.104173
51. Kirchhoff, T., Ramisch, K., Feucht, T., Reif, C., & Suda, M. (2022). Visual evaluations of wind turbines: Judgments of scenic beauty or of moral desirability? *Landscape and Urban Planning*, *226*, 104509. https://doi.org/10.1016/j.landurbplan.2022.104509
52. Sonnberger, M., & Ruddat, M. (2017). Local and socio-political acceptance of wind farms in Germany. *Technology in Society*, *51*, 56–65. https://doi.org/10.1016/j.techsoc.2017.07.005
53. Baxter, J., Walker, C., Ellis, G., Devine-Wright, P., Adams, M., & Fullerton, R. S. (2020). Scale, history and justice in community wind energy: An empirical review. *Energy Research & Social Science*, *68*, 101532. https://doi.org/10.1016/j.erss.2020.101532
54. Gross, C. (2007). Community perspectives of wind energy in Australia: The application of a justice and community fairness framework to increase social acceptance. *Energy Policy*, *35*(5), 2727–2736. https://doi.org/10.1016/j.enpol.2006.12.013
55. Pohl, J., Gabriel, J., & Hübner, G. (2018). Understanding stress effects of wind turbine noise – The integrated approach. *Energy Policy*, *112*, 119–128. https://doi.org/10.1016/j.enpol.2017.10.007
56. Goedkoop, F., & Devine-Wright, P. (2016). Partnership or placation? The role of trust and justice in the shared ownership of renewable energy projects. *Energy Research & Social Science*, *17*, 135–146. https://doi.org/10.1016/j.erss.2016.04.021
57. Ryder, S., Walker, C., Batel, S., Devine-Wright, H., Devine-Wright, P., & Sherry-Brennan, F. (2023). Do the ends justify the means? Problematizing social acceptance and instrumentally-driven community engagement in proposed energy projects. *Socio-Ecological Practice Research*, *5*(2), 189–204. https://doi.org/10.1007/s42532-023-00148-8
58. ter Mors, E., & van Leeuwen, E. (2023). It matters to be heard: Increasing the citizen acceptance of low-carbon technologies in the Netherlands and United Kingdom. *Energy Research & Social Science*, *100*, 103103. https://doi.org/10.1016/j.erss.2023.103103
59. 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. https://doi.org/10.1016/j.erss.2017.05.016
60. Haac, R., Kaliski, K., Landis, M., Hoen, B., Rand, J., Firestone, J., Elliott, D., Hübner, G., & Pohl, J. (2019). Wind turbine audibility and noise annoyance in a national U.S. survey: Individual perception and influencing factors. *The Journal of the Acoustical Society of America*, *146*(2), 1124–1141. https://doi.org/10.1121/1.5121309

61. Pedersen, E., & Persson Waye, K. (2007). Wind turbine noise, annoyance and self-reported health and well-being in different living environments. *Occupational and Environmental Medicine*, *64*(7), 480–486. https://doi.org/10.1136/oem.2006.031039

62. Müller, F. J. Y., Leschinger, V., Hübner, G., & Pohl, J. (2023). Understanding subjective and situational factors of wind turbine noise annoyance. *Energy Policy*, *173*, 113361. https://doi.org/10.1016/j.enpol.2022.113361

63. Pohl, J., Rudolph, D., Lyhne, I., Clausen, N.-E., Aaen, S. B., Hübner, G., Kørnøv, L., & Kirkegaard, J. K. (2021). Annoyance of residents induced by wind turbine obstruction lights: A cross-country comparison of impact factors. *Energy Policy*, *156*, 112437. https://doi.org/10.1016/j.enpol.2021.112437

64. Kim, E.-S., & Chung, J.-B. (2019). The memory of place disruption, senses, and local opposition to Korean wind farms. *Energy Policy*, *131*, 43–52. https://doi.org/10.1016/j.enpol.2019.04.011

65. Rudolph, D., Kirkegaard, J., Lyhne, I., Clausen, N.-E., & Kørnøv, L. (2017). Spoiled darkness? Sense of place and annoyance over obstruction lights from the world's largest wind turbine test centre in Denmark. *Energy Research & Social Science*, *25*, 80–90. https://doi.org/10.1016/j.erss.2016.12.024

66. Fergen, J., & B. Jacquet, J. (2016). Beauty in motion: Expectations, attitudes, and values of wind energy development in the rural U.S. *Energy Research & Social Science*, *11*, 133–141. https://doi.org/10.1016/j.erss.2015.09.003

67. Slattery, M. C., Johnson, B. L., Swofford, J. A., & Pasqualetti, M. J. (2012). The predominance of economic development in the support for large-scale wind farms in the U.S. Great Plains. *Renewable and Sustainable Energy Reviews*, *16*(6), 3690–3701. https://doi.org/10.1016/j.rser.2012.03.016

68. Jones, C. R., & Eiser, J. R. (2009). Identifying predictors of attitudes towards local onshore wind development with reference to an English case study. *Energy Policy*, *37*(11), 4604–4614. https://doi.org/10.1016/j.enpol.2009.06.015

69. Read, D. L., Brown, R. F., Thorsteinsson, E. B., Morgan, M., & Price, I. (2013). The Theory of Planned Behaviour as a model for predicting public opposition to wind farm developments. *Journal of Environmental Psychology*, *36*, 70–76. https://doi.org/10.1016/j.jenvp.2013.07.001

70. Figari, H., Leiren, M. D., & Krange, O. (2024). After the battle: Emergent norms and the silencing of dissent in a Norwegian wind power community. *Energy Research & Social Science*, *118*, 103765. https://doi.org/10.1016/j.erss.2024.103765

71. Schmidt, H., Leschinger, V., Müller, F. J. Y., de Vries, G., Renes, R. J., Schmehl, R., & Hübner, G. (2024). How do residents perceive energy-producing kites? Comparing the community acceptance of an airborne wind energy system and a wind farm in Germany. *Energy Research & Social Science*, *110*, 103447. https://doi.org/10.1016/j.erss.2024.103447

72. Schmidt, H., Müller, F. J. Y., Leschinger, V., de Vries, G., Schmehl, R., Renes, R. J., & Hübner, G. (2026). Predicting the Community Acceptance of Airborne Wind Energy with the Integrated Acceptance Model: Insights from Two Test Sites. *Journal of Environmental Psychology*, 103021. https://doi.org/10.1016/j.jenvp.2026.103021

73. Schmidt, H., Yupa-Villanueva, R. M., Ragni, D., Merino-Martínez, R., van Gool, P. J. R., & Schmehl, R. (2025). Exploring noise annoyance and sound quality for airborne wind energy systems: Insights from a listening experiment. *Wind Energy Science*, *10*(3). https://doi.org/10.5194/wes-10-579-2025

74. Casagrande Hirono, F., Robertson, J., & Torija Martinez, A. J. (2024). Acoustic and psychoacoustic characterisation of small-scale contra-rotating propellers. *Journal of Sound and Vibration*, *569*, 117971. https://doi.org/10.1016/j.jsv.2023.117971

75. Torija, A. J., & Nicholls, R. K. (2022). Investigation of metrics for assessing human response to drone noise. *International Journal of Environmental Research and Public Health*, *19*(6), 3152. https://doi.org/10.3390/ijerph19063152

76. Kawai, C., Jäggi, J., Georgiou, F., Meister, J., Pieren, R., & Schäffer, B. (2024). Short-term noise annoyance towards drones and other transportation noise sources: A laboratory study. *The Journal of the Acoustical Society of America*, *156*(4), 2578–2595. https://doi.org/10.1121/10.0032386

77. König, R., Babetto, L., Gerlach, A., Fels, J., & Stumpf, E. (2024). Prediction of perceived annoyance caused by an electric drone noise through its technical, operational, and psychoacoustic parameters. *The Journal of the Acoustical Society of America*, *156*(3), 1929–1941. https://doi.org/10.1121/10.0028514

78. Airborne Wind Europe. (2025). *Securing local support for airborne wind energy projects – A guide for project developers*. https://justwind4all.eu/wp-content/uploads/2025/10/AWEEnergy-Read_V5.pdf

79. Dropmann et al. (2026): *GrowFlowFly. Digitales Partizipationstool für die Energiewende. Verbundprojekt GrowFlowFly – Akzeptanzpotenzial für flächenextensive Erneuerbare Energien – APV, FPV, AWE im Vergleich mit etablierten Erneuerbaren Energie-Technologien* [Projektbericht].