Renewable and Sustainable Energy Reviews 221 (2025) 115693

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Barriers and benefits of public participation in energy transitions: A meta-analysis of empirical evidence from Central Europe

Jörg Radtke

RIFS Research Institute for Sustainability | at the GFZ - Helmholtz Centre Potsdam, Germany

ARTICLE INFO

Keywords:
Energy transition
Public participation
Energy democracy
Energy justice
Civic engagement
Procedural justice
Energy planning
Collaborative governance
Conflict resolution
Citizen involvement
Participation barriers
Democratic legitimacy
Community empowerment
Social acceptance
Stakeholder engagement

ABSTRACT

Public participation plays a critical role in energy transitions by enhancing democratic legitimacy and procedural justice. This paper reviews 129 studies from Austria, Germany, and Switzerland, focusing on the effectiveness of participatory processes in energy transition projects. Key participation formats included dialogues, information events, town hall meetings, working groups, and referenda, which were analyzed according to various dimensions such as procedural design, inclusiveness, and outcomes.

The findings highlight both opportunities and limitations of public participation. Effective participation fosters transparency, trust, and social acceptance, particularly when stakeholders are involved early and given meaningful influence, and processes are transparent. However, challenges such as insufficient early engagement, power imbalances, and low trust in authorities often undermine these benefits. Many participatory processes are limited to information dissemination or consultation, offering minimal empowerment to citizens. The evaluation also reveals that participation is not a guaranteed pathway to acceptance; poorly designed processes can lead to increased resistance and mistrust.

This study identifies systemic deficits, including inadequate integration of local contexts, limited decision-making autonomy, and superficial engagement practices, which diminish the potential of participation to achieve its goals. Addressing these barriers requires embedding participation into legal frameworks, fostering inclusivity, and developing adaptive, context-specific strategies.

A closer look into practices of public participation indicates that the potential for procedural justice is often underutilized. The most important aspects are personalized individual influences, implementation issues, acceptance, legal frameworks, and local relevance. Based on these insights, the author derives policy recommendations for better participation strategies, procedures, and practices, as well as outlines crucial research challenges for analyzing future participatory energy transitions.

1. Introduction: the meaning of participation in energy transitions

In recent years, a variety of participatory procedures have been explored, creating opportunities for experimentation in involving citizens in energy transition processes. Despite numerous studies documenting democratic practices aimed at increasing citizen participation, there is a lack of comprehensive scientific evaluation of these initiatives. Some studies highlight positive democratic practices, while others reveal significant drawbacks, inconsistencies, and declining civic engagement in complex participatory contexts.

Based on these findings, the author examines the question of whether the greater use of participatory processes in energy transitions has improved the democratic legitimacy of policy measures for the expansion of renewable energy and grid development. To answer this question, the author conducted a meta-analysis of case study results that cover empirical findings from Austria, Germany, and Switzerland.

Several meta-evaluations of various case studies confirm that the potential for procedural justice is often not fully realized [1–3]. This seems to indicate that (public) participation procedures in energy transitions are generating deficits, drawbacks, and pitfalls. Our review aims to identify common barriers and limitations to effective participation and suggests options for improving process design to overcome these challenges.

The literature review of this paper is based on an analysis of 129 research papers selected through systematic searches on Scopus,

This article is part of a special issue entitled: Energy Transitions: Social Science Perspectives published in Renewable and Sustainable Energy Reviews.

E-mail address: joerg.radtke@rifs-potsdam.de.

https://doi.org/10.1016/j.rser.2025.115693
Received 31 August 2024; Received in revised form 21 March 2025; Accepted 29 March 2025
Available online 4 June 2025

ScienceDirect, Google Scholar, Web of Science, and ResearchGate, complemented by targeted web searches. The review focuses on participation in energy transitions in Austria, Germany, and Switzerland, countries chosen due to their similar energy transition agendas as well as substantial German-language energy research. The review period spans from 2012 to 2023, covering the critical phases of the *Energiewende* and related policy developments in all three countries. The analysis concentrates on public participation in renewable energy projects and grid expansions, but also includes studies on nuclear waste management and fracking.

The participation formats examined include dialogues, information events, town hall meetings, working groups, and referenda. The research dimensions include case study areas, conceptualization and measurement of participation, research design of studies, number of empirical case studies, effects of participation and mechanisms identified, explanations for non-findings, challenges identified, target groups, methods and forms of participation, and responsibilities within participation procedures.

The review categorizes participation into various levels (informing, consultation, inclusion, empowerment, manipulation/therapy) and types of participation (acceptance and attitudes, discourse, decision-making, legitimacy, protest). It also considers different types of energy (e.g. wind, photovoltaic, biogas) and participation practices (top-down, bottom-up, financial participation, conflict management). At the same time, the review highlights the significant challenges in coding the wide variety of participation descriptions and ensuring meaningful evaluations.

The specific focus of the review is on obstacles, challenges and limitations in participation processes. The author identifies four types of deficits in energy participation processes: individual influences and roles; implementation issues; patterns of acceptance; and the meaning of local relevance such as place attachments and identities. Individual influences and roles impact participation in contexts in which personal demands, opinions, trust in external parties, and expectations are of particular significance. Implementation issues include limited decision-making autonomy, inadequate participation opportunities, poor dialogue and design, transparency challenges, early involvement deficits, perceived unfairness, and complexity in information dissemination. Acceptance issues, legal frameworks, and locally relevant topics also present barriers, such as incompatibility with local tourism, health concerns, quality of life, and environmental protection. Additionally, there are systemic issues like the lack of public benefit, deep-rooted local conflicts, and loss of trust towards authorities and experts. These deficits highlight the need for improved participation processes that address individual roles, ensure effective implementation, foster acceptance, and consider local relevance.

This study addresses several significant gaps in the current understanding of public participation in energy transitions, offering novel insights into both theoretical and practical challenges. Firstly, the review identifies the persistent barriers that hinder effective participation in such transitions, including power imbalances, late-stage engagement, and insufficient transparency. Secondly, it emphasizes the need to integrate participation processes across different scales—local, regional, and national—highlighting how diverse institutional frameworks affect public involvement. Thirdly, the study critically evaluates the potential of participatory approaches to enhance procedural justice and legitimacy, beyond mere instrumental benefits. By systematically analyzing 134 case studies from Austria, Germany, and Switzerland, it sheds light on the often-overlooked dynamics of localized opposition, constructive dissent, and learning processes within participation frameworks.

Some of the key research questions guiding this study include: What are the most common barriers to effective public participation in energy transitions? How do institutional and procedural differences across countries influence participation outcomes? What role does the conceptualization of procedural justice play in achieving more inclusive and equitable participatory processes? By addressing these questions, the study aims to provide actionable recommendations for designing participation strategies that are both context-sensitive and theoretically grounded. Ultimately, it seeks to contribute to the broader discourse on energy democracy by identifying pathways to more inclusive and impactful citizen engagement in the energy transition.

2. Theoretical background: conceptualizing participation in energy transitions

Research on the social acceptance of renewable energy infrastructure has long emphasized that public support for such projects is not only dependent on the characteristics of the project – e.g. its design, the technology used, etc. – but also on the implementation process [4,5], and in particular the way in which affected societal actors and their interests are integrated [6]. However, the empirical findings on whether and how participation helps to successfully realize the infrastructure projects necessary for the energy transition are fragmented and inconsistent. While many studies have documented the fact that early involvement and participation matter, it is unclear whether and under which conditions participation is in fact conducive to social acceptance and successful implementation processes.

The author argues that one important reason for this inconsistency is that existing research varies considerably in how it conceptualizes "participation" and "inclusion", and systematic comparisons between different types of participation are rare [6,7]. This conceptual ambiguity has constrained the analytical clarity of theoretical and empirical approaches to citizen participation [8]. Aitken et al. [9] posit that the conceptual complexity of public participation empirically results in a variety of "engagement methods" which, however, predominantly focus on consultation and awareness-raising. Furthermore, previous research offers limited insight into the effectiveness of different modes of political participation, specifically what a successful "community engagement plan" [10] should entail.

Moreover, participation can be studied from the perspective that "good" participation increases acceptance, but also from the viewpoint that democratic deficits in energy transition projects are an important reason why many projects fail. This research argues that these are not just two sides of the same coin. Put differently, while participation deficits may trigger opposition to a project, it is not evident that avoiding these deficits generates acceptance. Rather, while people might consider some procedural aspects as a requirement for accepting a certain project, these aspects might not be enough to make an undesired project acceptable to them (see Ref. [6]).

Beyond that point, public participation in energy transitions can be analyzed through different scholarly perspectives, each emphasizing distinct aspects of involvement. Policy studies view participation as a top-down process, enhancing policy legitimacy and acceptance but often lacking deeper democratic engagement [11–16]. Transition studies take a bottom-up approach, highlighting community-driven empowerment and participatory governance in decentralized energy projects [11, 17–20]. Planning studies focus on collaborative and iterative participation, emphasizing stakeholder dialogue and consensus-building, particularly in regional planning [21–24]. Meanwhile, science and technology studies (STS) conceptualize participation as co-creation and co-design, integrating diverse expertise in innovation processes, such as citizen science and participatory technology assessments [25–31]. This review prioritizes policy and planning perspectives, while acknowledging that elements of emancipatory and co-creative participation exist within structured participation procedures, such as planning workshops and citizen-led initiatives. The discussion will analyze how these aspects emerge in empirical findings and their relevance in addressing participation deficits in both research and practice.

2.1. Spotlighting procedural justice as the guiding light for energy democracy

Procedural justice is a key element in ensuring democratic legitimacy and equitable participation in energy transitions. It emphasizes transparency, inclusiveness, and fairness in decision-making, ensuring that affected communities can meaningfully engage in shaping energy projects. Various scholars define procedural justice as the way individuals and groups are included in decision-making and their ability to influence these processes [32]. Jenkins et al. (date) emphasize the importance of equitable procedures, ensuring that all stakeholders can participate without discrimination and have access to decision-making processes [33,178]. This is achieved through local knowledge mobilization, greater information disclosure, and institutional representation. Accordingly, procedural justice is often categorized into three key dimensions: information provision, inclusiveness, and participation [34]. In concrete terms, this means that communities must be involved in decision-making, be given fair and informed consent opportunities, and be consulted genuinely in environmental and social impact assessments [35].

Assessing procedural justice in participatory processes requires addressing who is included in decision-making, whether vulnerable groups are represented or excluded due to elite dominance, and whether decision-making frameworks integrate diverse knowledge systems to address injustice [36]. From an outcome perspective, procedural justice manifests in people's satisfaction with decisions, perceptions of fairness, and support for authorities [37]. A deliberative approach to democratic processes suggests that participation should foster diverse perspectives, encourage learning, and allow people to challenge or refine their beliefs through practical reasoning [38]. Based on these theoretical foundations, procedural justice in participatory processes can be analyzed through three primary aspects: transparency and accountability, reflexivity and inclusiveness, and fairness in decision-making [39].

In the context of utility-scale wind energy planning, procedural justice is assessed through four core dimensions [2].

1. **Participation** – A just procedure ensures representation of all affected groups. For example, participatory processes should be held in accessible locations, in local languages, and structured to facilitate broad community inclusion.
2. **Information** – Public notification must be affordable, timely, and provided through neutral intermediaries. Systematic efforts should identify and address knowledge gaps that are relevant to decision-making, ensuring that both decision-makers and the public have equal access to essential information.
3. **Decision-Making** – A fair process involves consistent and impartial decision-making. This includes the ability to adjust decisions based on new information, considering multiple and potentially conflicting criteria in the process.
4. **Local Context** – The role of place-based identities is critical in understanding community attitudes toward wind energy projects. Policymakers need to recognize the unique spatial, cultural, and aesthetic factors influencing public perception and acceptance.

Research, particularly in wind energy planning, confirms that fair and transparent processes are crucial for increasing public acceptance [40–46]. Studies indicate that individuals may accept energy projects, even if they initially opposed them, provided they perceive the decision-making process as fair and inclusive. This challenges the notion that the ends justify the means in energy infrastructure planning [47]. However, achieving meaningful participation is demanding, as it requires genuine opportunities for communities to influence regulatory decisions [48, p. 406]. Key expectations include ensuring concerns are taken seriously, allowing active community involvement, and facilitating inclusive engagement.

One of the most significant aspects of procedural justice is the integration of local knowledge into planning processes [49] and the recognition of place attachments and local identities [50]. Additionally, procedural justice is closely linked to multi-level legal frameworks, in which different jurisdictional, spatial, and temporal scales influence how justice is perceived and implemented [33]. Normative assessments of justice vary across governance levels—at the national level, climate protection goals and cosmopolitan values often take precedence, whereas at the local level, homeland protection and communitarian values play a more significant role [51].

The following review will evaluate how participatory processes incorporate procedural justice principles, focusing on access, representation, fairness, involvement, and local recognition. By assessing both best practices and reported deficiencies, this study aims to offer insights into how public participation can be effectively designed to enhance social acceptance and democratic legitimacy.

2.2. Conceptualizing participation by levels of inclusion

Public participation can take various forms and trigger different acceptance mechanisms. This study adopts a three-dimensional conceptualization based on Fung ([52], see also [53]).

The first dimension concerns the *level of inclusion*, similar to the IAP spectrum of participation (www.iap2.org) (see Table 1). It ranges from merely informing the public, to consulting them for feedback, to actively integrating community input, and ultimately to empowering the population to make political decisions.

The second dimension relates to the *selection of participants*. Some processes are open to all, while others are selective, based on criteria such as interest, knowledge, or influence. Bottom-up approaches tend to foster more inclusive participation, whereas top-down processes often result in more selective involvement. This is due to the fact that, on the one hand, only certain interested and informed individuals are addressed, and on the other hand, the offered participation formats entail structural, cognitive, and habitual access barriers.

The third dimension addresses the *intensity of communicative exchange*, ranging from passive listening to discussions that foster learning, and even negotiation processes aimed at reaching compromises.

This framework enables a structured analysis of participation, particularly in terms of procedural justice. By embedding results within the theoretical framework, the study ensures that participation is examined not only as a tool for fostering acceptance but also as a mechanism for learning, co-creation, and empowerment. This approach highlights both the empirical and normative contributions of participation in energy transitions.

Building on the structured framework of participation dimensions, it is essential to consider how participation functions across different

Table 1
Levels of inclusion – the first dimension of public participation.

Level of inclusion	Conceptualization	Examples
Information	One-sided information about the project given by the project owner to the population	Information leaflets, website, documentation
Consultation	Project developers seek to obtain feedback	Information event with feedback opportunity, Q&R Likely also involves more *informal* dialogue
Involvement	Project developers seek to integrate the community's concerns by involving the population in project development	Population more formally involved in the process, i.e. through *Bürgerräte* (citizens' assemblies) workshops, round tables with different stakeholders
Empowerment	The population can make political decisions about the final project	Political decisions made by the population (assembly or ballot vote)

governance levels in energy transitions. Public participation operates at local, regional, and national scales, each with distinct challenges and opportunities for fostering procedural justice and democratic legitimacy [54–59]. Local participation addresses community-specific concerns such as landscape changes, health risks, and economic effects, often through town hall meetings or advisory panels. However, dominant voices may overshadow marginalized groups, and local interests can sometimes clash with national strategies [60]. Regional participation serves as a bridge, coordinating multiple communities and addressing cross-community issues like infrastructure and resource allocation [61–63]. While it allows for broader collaboration, ensuring transparency and fair representation remains a challenge. At the national level, participation influences policies on renewable energy targets and large-scale planning [64–66]. However, these processes often feel disconnected from local realities, leading to skepticism and resistance if public input is not meaningfully integrated. A multi-level governance approach is crucial for aligning participation across scales, ensuring inclusivity, transparency, and fairness [67–70].

Participation also plays a key role in fostering social acceptance and democratic legitimacy. Two theoretical perspectives highlight its importance. First, incorporating public concerns and expertise leads to better project outcomes, particularly in smaller municipalities where consensus is easier to achieve [4,71,72]. Second, the procedural justice perspective argues that participation has intrinsic value—people are more likely to accept decisions if they feel heard and treated fairly, even if all concerns are not fully addressed [6,40,73,74]. Research shows that transparent and inclusive processes increase long-term trust and acceptance of energy projects [75]. This reinforces the concept of energy democracy, emphasizing justice and equity as core principles of the energy transition [76,77].

At the same time, inadequate participation processes can undermine public trust and lead to increased opposition, even among initial supporters. If participation appears insincere or ineffective, communities may feel excluded, leading to resistance—even among those initially supportive of energy transitions [7,41,74,78,79]. Developers must proactively engage communities from the outset, ensuring transparency and meaningful influence. Pseudo-inclusion—participation without real impact—can be more damaging than no participation at all [40,74]. To prevent conflict, procedural justice must be embedded into decision-making, allowing for adjustments based on evolving public concerns [10,73,78,80,81].

These insights underscore the necessity of scale-sensitive, inclusive participation frameworks that balance local realities with broader policy objectives. To further explore the complexities of participation, the following literature review examines key theoretical perspectives, empirical findings, and existing research gaps in the field [82–86].

3. Methods

For this literature review, the author examined a total of 129 research papers (see Table A3 for a comprehensive overview of all papers in the appendix).

The collection was compiled via a systematic search on the web portals Scopus, ScienceDirect, Google Scholar, Web of Science, and ResearchGate. Where necessary, the author complemented the selection with a targeted web search to discover specific papers (snowball system). The reviewed literature includes a mix of journal articles, book chapters, monographs, and grey literature, reflecting the interdisciplinary nature of the topic (see Table 2). Among the 61 journal articles, a significant number were published in leading energy policy and social science journals, such as Energy Research & Social Science (10), Energy Policy (9), and Renewable and Sustainable Energy Reviews (8). Additionally, 36 book chapters and 23 reports, working papers, and conference proceedings were analyzed to capture broader discussions beyond peer-reviewed publications. The search terms were strategically selected to capture the diverse aspects of public participation in energy transitions. Key terms included “energy transition,” “public participation,” “energy democracy,” “energy justice,” “civic engagement,” and “procedural justice.” The focus was on participatory procedures in the context of renewable energy projects, grid expansions, nuclear waste management, and fracking. The author coded the energy types investigated in the papers during the process. In two cases, the energy type could not be specified because the papers were theory-based. 39 papers did not focus on a specific energy type but looked at renewable energy infrastructure in general. The two most frequently encountered categories were wind energy with 41 cases and grids with 40 cases. Other types of energy were dealt with significantly less, such as solar power (15 cases), biogas (7 cases), geothermal energy (5 cases), hydropower (3 cases), nuclear waste (2 cases), and fracking (1 case).

Table 2
Type of material.

Journal Articles	61
Energy Research & Social Science	10
Energy Policy	9
Renewable and Sustainable Energy Reviews	8
Utilities Policy	7
Renewable Energy	2
Journal of Cleaner Production	2
Others	23
Book Chapter	36
Grey Literature (Reports, Working Papers, Conferences etc.)	23
Monography	8
Scientific Anthology	1

The search was structured by three essential criteria. First, the author focused on the three countries Austria, Germany, and Switzerland. The selection of these countries was primarily due to the fact that all three share a common language, thus facilitating the research process. Thus, the majority of the reviewed literature is in German (77 studies, 52 in English). Despite this shared language, however, the countries differ substantially in their institutional and constitutional structure, meaning that the ways in which they seek to undertake participatory procedures could differ significantly. This is quite interesting, as despite the fact that each country is pursuing a fossil-free energy agenda including a central strategy to expand renewable energies, the differences in how each of these strategies are implemented could yield insights for the relationship between public participation procedures and energy transition policy implementation more broadly. The selection also reflects the countries' overlapping institutional and constitutional frameworks. While differences exist in governance structures, similarities in energy policy strategies are evident, driven partly by shared obligations under European Union legislation, such as the Aarhus Convention. These countries exhibit comparable approaches to public participation in energy transitions, emphasizing inclusivity, transparency, and fairness across national, regional, and local levels. The literature highlights alignment in strategies aimed at expanding renewable energy, driven by policies like the EU's Renewable Energy Directive, which harmonize practices across member states [87–90]. In this literature review, the author acknowledges variations but focusing on overarching patterns that resonate across institutional contexts. Participatory procedures in these nations reflect not entirely divergent, but interlinked dynamics shaped by shared legal and policy frameworks. The empirical analysis thus captures both convergences and divergences, shedding light on best practices and areas for improvement in fostering more inclusive participatory energy transitions.

Of course, it is also true that several other European countries are implementing central strategies to facilitate the energy transition. However, another reason for our choice was the fact that these countries have been extensively researched, especially with regard to participation and inclusion. To achieve a comprehensive overview that includes all the relevant studies in a specific area, it is important to capture a large amount of research. While the author is aware of the fairly different policy regimes in Austria and Switzerland, the specific policy

conditions are negligible in the context of our research topic, as no significant differences exist regarding participation incentives and strategies in national, regional, and local energy policies. Crucially, no limiting factors for participation exist that would impact comparability. Some studies from other regions around the world were also included. This allows us to integrate overall insights into participatory energy transitions from outside the case and/or country studies, enabling us to conduct comparisons with the core dataset and thus present unique findings on core principles and procedures of energy participation. The author has chosen only those papers which have an outstanding impact on research, promising the most decisive results (e.g. citation rates).

The distribution of spatial levels in the reviewed studies reveals a strong emphasis on national (50) and regional (36) contexts, indicating that most research on public participation in energy transitions focuses on governance frameworks and decision-making processes at higher administrative levels (see Table 3). The regional category reflects cases in which studies specify a federal state, highlighting the role of subnational governance in shaping participatory processes. In contrast, local-level participation (9 cases)—in which a specific town or municipality is mentioned—appears less frequently. This suggests that while local engagement is crucial, it may be underrepresented in the literature or integrated into broader regional analyses. Global (7) and European (7) studies reflect international comparisons or supranational governance influences, such as EU energy policies.

The time period for the selection of papers ranges from 2012 to 2023. The distribution of publication years reflects the increasing academic focus on public participation in energy transitions, particularly since 2012 (see Fig. 1). The peak in 2017 and 2018 indicates a surge in research interest, likely driven by global energy policies and climate commitments. The decline in 2022 and 2023 may reflect shifts in research priorities or delays in publication rather than diminished relevance.

In Germany, the decision to initiate the *Energiewende* was made in 2011; in the same year, a similar policy process started in Switzerland as a reaction to the Fukushima nuclear accident, resulting in the Energy Strategy 2050. In Austria, an obligatory introduction of European energy directives was confirmed in 2009 and 2020, aiming to expand renewables and reduce greenhouse gas emissions. The author can therefore conclude that all three countries are pursuing the same energy transition path, mainly based on policies to expand renewables. Opportunities for participation were created by the subsequent roll-out of concrete strategies and measures. The data collection period thus covers the essential processes of the *Energiewende* in all three countries. It also reflects the release dates of existing studies on this issue.

Second, the author has the types of energy context in which participation procedures are initiated, mainly related to renewable energies and grid expansion (see Fig. 2). This mirrors the essential measurements of the *Energiewende* in Austria, Germany, and Switzerland on the one hand, and illustrates the practice of public participation in the planning of energy facilities on the other. The author also covers some other types of energy infrastructure such as nuclear waste management and fracking, because some research studies also included aspects of these technologies.

Third, this study focuses on public participation in energy transitions. Therefore, the range of participation formats covers dialogues, information events, town hall meetings, working groups, and referenda as the most common procedures in energy transitions. The overview of participation methods highlights the diverse approaches used to engage the public in energy transition processes (see Table 4). The most frequently cited methods include surveys, opinion polls, and information events (19 each), followed closely by round tables (16), online information (15), and workshops (12). These methods indicate a strong emphasis on information dissemination and structured dialogue as key tools for public engagement. Other commonly used formats, such as site visits, consultations, and mediation processes (11 each), reflect efforts to enhance transparency, address conflicts, and facilitate citizen input. Meanwhile, participatory approaches like citizen conferences (10) and public hearings (6) underscore the role of formalized deliberative forums in decision-making. Less frequently cited but still notable are financial participation (6), citizens' initiatives (5), and legal objections (3), which illustrate the range of influence mechanisms available to the public—from advisory roles to direct legal action. Additionally, digital participation tools such as online platforms, comment functions, and social media debates signal a growing reliance on digital engagement.

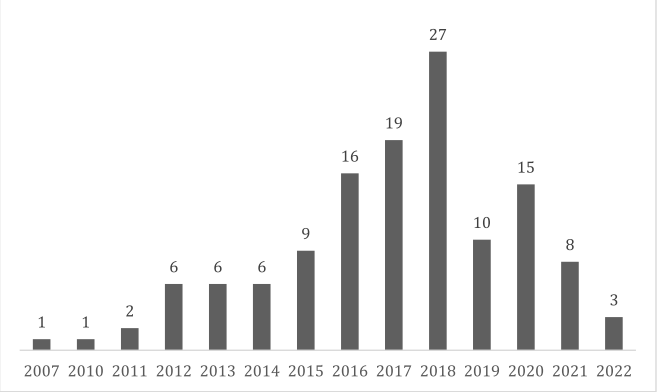

Fig. 1. Year of publication.

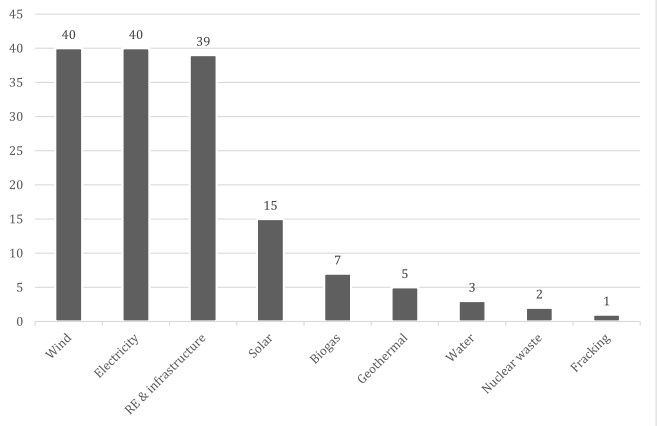

Fig. 2. Types of energy included in the evaluation.

Table 3
Spatial levels represented in the studies.

National	50
Regional	36
Local	9
Global	7
European	7
Not defined	5

Table 4
Most frequent participation methods.

Surveys/Questionnaire/Opinion Polls	19
Information Events	19
Round Tables	16
Online Information	15
Workshops	12
Site Visits/Excursions	11
Consultations	11
Dialogue Formats	11
Mediation/Negotiations/Conflict Management	11
Citizen Conferences	10

Table 5
Overview of research categories for the literature review.

Basic information	**Form/depth of participation**
Project topic	*Manipulation/therapy*
Case study area	*Informing/consulting/inclusion/empowerment*
How is participation/inclusion conceptualized?	*Acceptance and attitude analysis*
How is participation/inclusion measured?	*Degree of information/knowledge query*
Research design I: causal/observational	*Protest analysis/discourse analysis/decision analysis*
Research design II: quantitative/qualitative	*Legitimation*
Effect of participation	
Mechanisms identified	
Explanations for non-findings	
Challenges/conditionalities identified	
Target groups	
Methods/forms of participation	
Responsibilities: host and funding	
Type of study	**Conceptualization of types of participation**
Empirical analysis/meta-study	*Different levels combined*
	What is the most inclusive level used in the process?
Form of energy	**Participation deficits**
Wind/electricity storage/grids/lines RE & infrastructure in general/solar/biogas	*People/roles (expressing and asserting one's own opinion/perception of/trust in official, external actors/expectation of participation/group of people involved)*
Geothermal energy/hydropower/nuclear (waste)/ fracking	*Implementation (lack of scope for decision-making/lack of opportunities for participation/access/implementation/dialogue deficits/transparency and early participation/fairness/information/complexity*
	Acceptance
	Legal framework for participation projects
	Locally relevant issues/restrictions
Participation practice	
Implementation of participation (top-down/bottom-up)	
Various participation formats	
Stakeholder participation	
Participation standards	
Financial participation	
Conflict management/avoidance	

However, these typical participation formats are not transferred to the system of categories used for coding, because it is more appropriate to use the most common levels of citizen participation for measuring the effects of participation on the influence and power of citizens, and more general participation categories such as participation in decision-making. Notwithstanding, the author takes the specific formats of participation such as dialogues into account when it comes to analyzing and evaluating participation practices in detail. With this selection and division of types of participation, the author is effectively covering the full range of the most crucial influencing factors (see Table A2 for a comprehensive overview of all research dimensions in the appendix).

In summary, the empirical material concentrates on public participation and the different forms it can take on, including protests, dialogues, and consultations. There is a focus on various renewable energy sources, primarily on wind energy, expansion of electricity grids, solar energy and hydropower. Different steps of the process are covered, like the project planning, the approval, and the construction of renewable energy facilities. The German experience is in focus, but different levels are covered, from the European to the local level. Different scientific approaches are used, including case studies and literature reports. Recommendations are given, participation methods are evaluated, and limiting factors are explored. The empirical material deals with different dimensions, such as the social, legal, spatial, environmental, democratic or policy dimension. Other topics discussed include acceptance, conflicts, and decision-making. Further down, these categories will be broken down more and extended upon.

The data from all the papers were analyzed using the analytical strategies of coding and qualitative content analysis [91–98]. Coding the data was done using the MAXQDA analytical tool. The author has combined an open coding scheme provided by Grounded Theory with more the deductive process of building coding categories, derived from the concepts of qualitative content analysis and top-down coding (structural and descriptive coding styles) [99–105]. Thus, the category system for analyzing the data was derived both from a range of predetermined categories of research objectives from literature, and from specific aims of this review study (comparison of research results on participation). These meta categories were developed from the theoretical and empirical literature on participation in energy transitions (see previous section) as well as from the comparative research perspective. Table 5 lists the categories used to structure the research dimensions of the analyzed studies (see Table A1 for a comprehensive overview of all categories in the appendix).

For the first two categories "levels of citizen participation" and "participation categories," the author has compiled the most important dimensions of participation in energy transition contexts from the literature. The third category "types of energy" maps common renewable energies, supplemented by power grid infrastructure, nuclear waste management, and fracking (see Fig. 2).

These are primarily the result of the energy types found in the papers analyzed. The third dimension "practices of participation" is a combination of categories from participation research ("top-down (invited) participation" and "bottom-up (invented) participation"[1]) and the more specific types and implementation of participation to be found in energy transitions ("standards of participation practice," "financial participation," "management and prevention of conflicts") (see Fig. 3).

[1] Invited spaces of participation are those structured and sanctioned by governments or institutional actors to include citizens in decision-making processes. However, these spaces often serve as controlled arenas in which participation is limited to predefined frameworks, reducing the potential for marginalized groups to exert meaningful influence over the decision-making process. Invented spaces of participation, in contrast, emerge from grassroots initiatives and collective actions of civil society to challenge existing power structures, creating alternative platforms for engagement that prioritize the voices of those typically excluded from formal decision-making processes. While invited spaces are often framed as democratic innovations to enhance participation, they may reinforce hierarchical control and limit dissent, whereas invented spaces enable more radical forms of political agency, allowing communities to contest exclusionary policies and advocate for substantive social change.

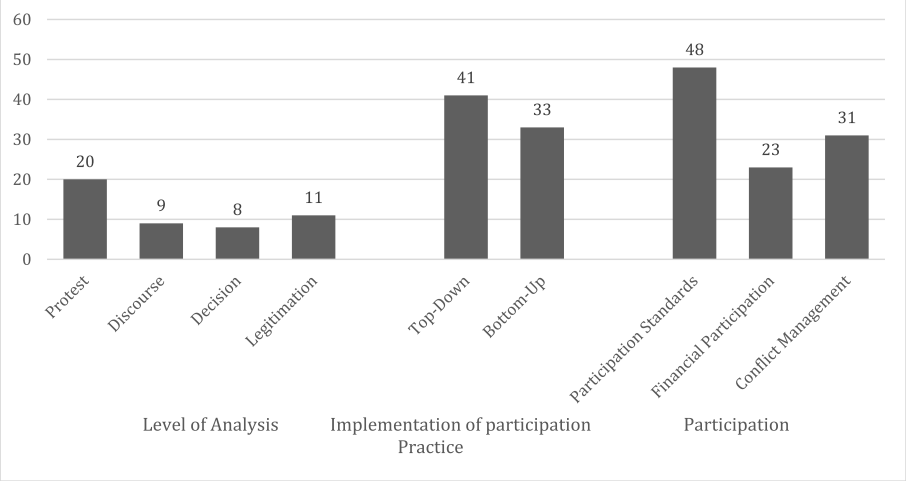

Fig. 3. Additional categories included in the evaluation.

Finally, the fourth dimension of "deficits of participation" is a particular focus of this review. All the categories are derived from the analyzed data by open coding, as this dimension is not consistently evaluated and standardized in research. Moreover, as this study aims to cover a broad range of limiting factors in participation, no data on this issue should be left out in coding. The author has generated five overall categories under which the deficits and negative aspects of participation can be subsumed ("personalized individual influences and specific role models," "implementation," "acceptance," "legal framework of participation initiatives and strategies," "issues of local relevance").

The main challenge in the coding process was that a very wide variety of descriptions of one single issue could be found in the data. This broad range and the manifold content-related expressions of types and practices of participation are hard to cover with one umbrella term. To limit the number of categories, the author decided to follow a more restrictive mode of selection by using the deductive coding style. The author therefore filtered for the relevant passages to allow a classification of the research directions and topics analyzed in the papers. Another problem lay in the further description of meaningful passages that make evaluations of the issues possible. To give an example, the author can classify one study as analyzing working groups in participation procedures. However, the author aims to ascertain the types of working groups and forms of specific participation, collaboration, and inclusion covered while also understanding the assessments derived by the author that enable us to evaluate this participation practice. This can be challenging if the content cannot be brought down to a common denominator in terms of our categories and the objective of this review. The author has dealt with this problem by retaining the large variety of descriptions in our selection of passages, ensuring that the author summarizes the contents in the best way without shortcutting and limiting the information value. See Table 6 for an overview of the most important categories used for coding (for the complete coding scheme see the code book in the appendix).

4. Empirical analyses

This chapter delves into the empirical analyses of public participation in energy transitions, focusing on how different levels of citizen involvement are manifested and evaluated in various studies. The analysis begins with an examination of the different levels of citizen participation, which range from simple information dissemination to more involved processes like consultation and co-decision-making. Following this, the author analyzes the conditions and effects of participation as evaluated by participants and respondents in research studies. The author then goes on to provide an overview of the most common practices of participation and put a specific focus on the evaluation of participation deficits.

4.1. Levels of citizen involvement

The levels of citizen participation found most often in the examined papers are consultation and informing, as found 54 times and 50 times respectively. In 42 cases, the type of participation could not be specified (see overview in Fig. 4).

Consultation is conceptualized as both formal and informal in the papers [56,106–113]. Some papers show possible event types which are seen as an important basis for participation [114] and can include many different stakeholders [108,115]. One event type that occurs frequently is different dialogue formats with various actors, such as citizens, stakeholders, and experts [56,112,116–122]. Other formats for including feedback from citizens are citizen forums [113,122–124], group discussions [123,125,126], citizen questionnaires and surveys [120,121,127,128], and question and answer sessions [118]. Further examples are round tables [56,117,119,121,122], workshops [56,116,118,129], joint conflict management [124], mediation [117,118], and citizen conferences [56,118]. Another format is contact groups that include participants who can contribute local knowledge [130]. Of those papers that study the effects of consultation, 19 find mixed results [42,107,111,112,114,115,120,125–127,129,131–137], while 10 papers find a positive effect [121,123,130,138–144], and 9 papers a negative one [56,108,116,119,128,145–148].

Informing is also often listed as a step in public participation, and frequently as the first step [42,106,107,137,149–151]. It can be formal or informal [106,107,116,152,153]. Informing can happen online such as via websites [116,120,125,132,154], in print media like newspapers or flyers [120,121,125,132,154], or in person. In-person events include general information events [114,120,121,129,132,147,153,155,156] and information markets [117,125]. Other formats mentioned are press coverage, reports by planners [9], and visits to plants [120]. Some articles underline the importance of early information [116,136,145,157,158] and that this can create trust and transparency [122,159]. While four studies find a positive effect [121,150,155,160], 15 studies find both negative and positive effects when informing is used [42,107,114,115,120,125–127,129,132,135–137,152,153], and 12 studies find a negative effect [116,119,145,147,148,154,159,161–165].

Inclusion appeared the third most with 26 findings. Some articles mention examples like negotiations with different stakeholders [122,134,166], advisory boards [126,134], and energy labs [144,167]. There are also many ways to actively include citizens, like citizen forums [122], future workshops [134], and online participation platforms

Table 6
Numerical summary of the most important categories.

Category	Number of articles
Case study area	
Germany	94
Europe	15
Global	10
Switzerland	7
Austria	6
Research design: quantitative/qualitative	
Qualitative	53
Mixed	29
Quantitative	13
Effect of participation	
Mixed	41
Positive	26
Not clear	23
Negative	21
Not identified	18
Form/depth of participation	
Consultation	54
Informing	50
Inclusion	26
Empowerment	9
Manipulation/therapy	5
Further level of analysis	
Acceptance and attitude analysis	56
Protest analysis	20
Legitimation analysis	11
Discourse analysis	9
Decision analysis	8
Form of energy	
Wind	40
Electricity storage/grids/lines	40
RE and infrastructure in general	39
Solar	15
Biogas	7
Geothermal energy	5
Water	3
Nuclear (waste)	2
Unclear	2
Fracking	1
Type of study	
Empirical analysis	85
Meta-study	28
Unclear	17
Implementation of participation	
Top-down	41
Bottom-up	33
Participation practice	
Participation standards	48
Conflict management/avoidance	31
Various participation formats	27
Stakeholder participation	23
Financial participation	22
Participation deficits	
Implementation/dialogue deficits	19
Transparency and early participation	18
Acceptance	16
Perception/trust in official external actors	16
Expressing and asserting one's own opinion	15
Locally relevant issues/restrictions	15
Legal framework for participation projects	14
Group of people involved	11
Lack of opportunities for participation/access	8
Fairness	7
Expectation of participation	5
Lack of scope for decision-making	5
Information/complexity	4

[132]. Further formats are round tables, town hall meetings, and planning cells [120]. This kind of participation can be both formal and informal [107,113]. In order for the results to be accepted, it is important that citizens and communities participate directly [6,156]. When goals are supported by a wide range of citizens, they are more likely to be accepted [157]. Another relevant concept is co-production [115,167]

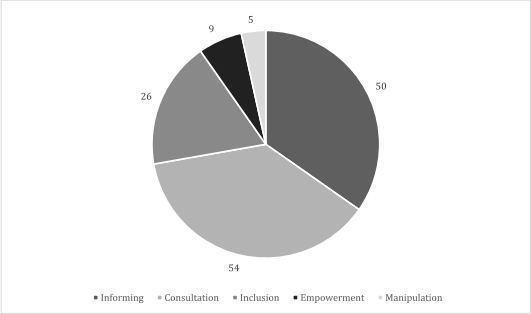

Fig. 4. Levels of citizen participation.

or co-design [157,167,168], meaning the involvement of citizens in deliberative processes of opinion formation [167]. Three studies find inclusion to have a positive effect [140,144,166], one study finds a negative effect [161], and eight studies find both positive and negative effects [42,107,115,126,132,137,168,169]. Most studies find no clear effect or make no conclusive claims [6,113,122,134,137,151,156,157,167,170,171].

Besides co-design, co-decision-making is also possible, i.e. decisions are delegated to the citizens [168]. This falls under the category of *Empowerment*, which was found in nine cases. Tools for empowerment include direct democratic tools like popular petitions (*Volksbegehren*), referenda (*Volksbefragung*), and popular votes (*Volksabstimmung*) [168]. An illustrative example of this is the Swiss popular vote on the energy act (*Energiegesetz*) in 2017 [172]. Another example of empowerment is the changing of laws and acts following protests [173]. In four studies, this was found to have both negative and positive effects [6,115,168,169], while one study found positive effects [140]. The positive effects of empowerment are more support for the project [6] and a higher-quality planning process [115].

With five codings, *Manipulation/therapy* appeared the least. One of the few examples of manipulation can be found in Ref. [174]. The researchers examine a solar energy project in Shenzhen, China in which government surveys were manipulatively designed. This category also covers alibi participation [42]. Therapy was found in cases in which project planners offered only limited participation opportunities after protests, or when the project was already at an advanced stage [165].

In conclusion, the analysis reveals that consultation and informing are the most common forms of citizen participation in energy transitions, yet their effectiveness varies widely (see Table 7). While these practices can promote dialogue and transparency, their outcomes are often mixed, highlighting the need for more meaningful and well-designed engagement strategies. Inclusion and empowerment, though less frequent, offer greater potential for fostering acceptance and legitimacy, but their success apparently depends on careful implementation.

4.2. Conditions and effects of participation

In the following, the author explores the empirical findings on public acceptance and attitudes towards energy transition projects, a critical factor for the success of such initiatives. Across the examined studies, various definitions and dimensions of acceptance are identified,

Table 7
Effects identified by level of citizen participation.

Levels of citizen participation	Effects identified				
	Positive	Negative	Mixed	Unclear	Total
Informing	4	12	15	19	**50**
Consultation	10	9	19	16	**54**
Inclusion	3	1	8	14	**26**
Empowerment	1	0	4	4	**9**

reflecting the complexity of how acceptance is conceptualized and measured. The author shows the different factors influencing acceptance, such as the design of participation processes, the attributes of specific projects, and individual socio-demographic factors. Additionally, the author addresses the role of information dissemination, protests, and legitimacy in shaping public attitudes toward energy transitions.

Studies that deal with *acceptance and attitudes* are found the most with 56 cases. Different definitions of acceptance can be found: one study describes it as acceptance of a licensing procedure and of the result (the decision) as fair and appropriate [160]; other authors claim that acceptance means that procedures are accepted but not necessarily their results [152,175]. Attitudes towards energy transition projects, including acceptance, can be uncovered by involving different stakeholders in participation procedures [127] and looking at their argument patterns [176] or forms of communication [177].

The papers also conceptualize acceptance in different ways. One approach differentiates between four dimensions: acceptance can be negative or positive, active or passive. It can thus have four forms: endorsement, active commitment, rejection, and resistance [120,121,125,178]. Another central conceptualization focusses on three dimensions, namely social, market, and community acceptance [178–181]. A further concept divides it into three forms: acceptance of renewable energies in general, acceptance of specific renewable energy types, and active acceptance [120].

For the energy transition, acceptance and support from all parts of society are needed, which makes participation relevant [167]. But results concerning the effect of public participation on acceptance are mixed. While some authors see a positive relationship between public participation and acceptance [6,137,144,182,183], opponents see the risk that it could create worries and fears (see literature review of [137]). Participation is not seen as a guarantee of acceptance [114,184,185].

In the papers analyzed, many factors are identified that influence acceptance. These factors can be grouped into different categories.

- *Design of participation processes:* opportunity for local community input [6,151,186], possibility for feedback [180], fairness and justice [120,175,187], trust [111,120,122], transparency [120,122,151], mechanisms for information about participation possibilities, technology, etc. [120,151,175,188]; degree of influence/self-efficacy [111,175,178,185,187], dialogue-oriented formats, early inclusion [113], responsiveness [151].
- *Attributes of the project*: economic participation [6,180], insight into the necessity of the project [178,185,189], utility [185], identification with the project [178,185]; economic [179,188], visual [179,189,190], and environmental impact [6,179,190]; positive public image [180], positive risk-benefit balance [178], geographical and technological characteristics [120,191], perceived side effects [191]. [6] sees these attributes as more important than the design of participation.
- *Individual factors:* socio-demographic factors (age, education, etc.) [179,188], political position, exposure to renewable energy infrastructure [179], acceptance prior to participation [171], acceptance of specific forms of RET [120].

Besides this, several studies underline the role of the level of information in acceptance. Some studies find that excess information concerning program disadvantages as well as alarming reports have negative effects on acceptance [192]. According to another paper [163], public acceptance is high when there are very low levels of information, while too much information can damage the level of public acceptance. When the level of uncertainty is high and knowledge is low, there is a general optimism about the project [181].

Another analysis level is *protest analysis,* which was found 20 times. Protests in the context of energy transition projects can occur when there is no willingness to compromise or negotiate [123]. Many of these studies [123,133,153,154,165,174,176,177,189,193–195] focus on local case study areas such as specific nature reserves [154], rest areas on highways [133], or villages [174]. A special form of protest that was found in the authoritative context of China was *defensive participation,* which involves communities participating in order to defend their interests [174]. The studies find that protests have different effects. In the examined cases, protests led to readjustments in climate policy and a slowdown of the energy transition [194], legislative changes in the area of energy grids [173], and delays in the expansion of energy transmission grids [196]. Furthermore, when protesters are able to establish a hegemonic discourse and significant media coverage, they can influence political decisions [197]. Despite these possible effects [133], asserts that protests should not merely be seen as an obstacle but also as having a constructive dimension.

Legitimacy analysis plays a role in 11 studies. The different types of legitimacy examined in the studies are output legitimacy [56,131,146], input legitimacy [56,131,146], and throughout legitimacy [56,116]. Legitimacy is seen as one of the factors for successful public participation in energy transitions [126,134,138,198]. At the same time, decisions can also be legitimized through public participation [159]. Legitimacy can be created through consultation and discourse with different stakeholders [56,126]. Other factors in creating legitimacy are the inclusion of spatially specific aspects [199], appropriate participation measures [126], innovation, and the relevance of results [200].

Decisions were analyzed in 10 cases. These papers deal with public participation in decision-making processes [6,127,131,164,187,197]. The inclusion of both the public and decision-makers can be helpful for finding community-based solutions [127]. Public participation enables citizens to supply information that is relevant for decisions [131] and enables procedures to be designed more fairly, which can lead to more acceptance [187]. Besides this, the public can also influence political decisions through protests [197].

Discourse analyses were found the least often, in nine papers. Some of the studies focus on discourses around conflicts and protests [153,158,195,197,201], and concern the local level [108,153,158,195]. One study investigates whether discourses change through participation – which could not be observed [108] – while another also looks at the discourses of supporters [195]. To study discourses, researchers focus for example on the representation of discourses in the media [158,202], on citizen initiatives [197,202], or local authorities [202].

Finally, the types of energy play a decisive role as the fundamental pillars and framework-building conditions for participation in energy transitions. The distribution of the individual forms of energy aligns with the distribution of the categories in general: for all energy types, consultation and informing were carried out the most. While for most energy types top-down and bottom-up strategies were balanced, for energy grids, top-down strategies were mostly used. Whether the effect is negative or positive is also fairly balanced. The exception are studies about general renewable energy infrastructure, which see negative effects in only two cases but positive effects in 10 cases.

In summary, the results show that while participation can positively influence acceptance, it does not guarantee it. The impact of participation is often mixed, with outcomes heavily dependent on the design and implementation of the participatory processes. Furthermore, the level of information provided, the management of protests, and the perceived legitimacy of the processes play crucial roles in shaping public attitudes. These findings underscore the need for carefully crafted participation strategies that consider the diverse factors influencing acceptance in order to achieve broader support for energy transition initiatives and policies.

4.3. Practices of participation

The concrete practices of participation are probably the most decisive factor in successful energy democracy. The following analysis

categorizes the different actors involved in participation processes and explores the effectiveness of their approaches, with a particular focus on how top-down and bottom-up strategies are employed and their respective impacts on public participation. The author also discusses the standards of participation practice, the role of financial participation, and the management and prevention of conflicts in these projects.

Top-down participation was coded 41 times in the papers. It is carried out by various different actors that can be grouped into different categories.

- Industry actors such as operators [129,132,137,139,193], project managers [114,147,161,173], and project sponsors [118,124].
- Political and administrative actors like members of public administration [124,147], local government actors [119,161,164], legislators [139,173], municipalities [193,203], state approval and planning authorities [110,118,193], federal states [124,169], and public agencies [106,123,124,167].
- Actors from civil society such as scientists and researchers [124, 129], civil society organizations [124], environmental and consumer protection organizations [117,119], and citizen initiatives [117].

In some cases, this type of participation is required by law [106,110] and is thus part of formal planning processes [110,118,185]. Examples include the German regional planning procedure (*Raumordnungsverfahren*) and planning approval procedure (*Planfeststellungsverfahren*) [142]. These processes can be informal as well [110, 118].

The role of the public in top-down participation is more passive [203]; it includes publishing plans [145,146], consultations [145,184], speaker events [204], hearings, conciliation [184], opinion surveys, round tables [137], online feedback [146], elections, and passive membership in organizations [203]. An illustrative example is the *Arbeitskreis Windenergie* (working group on wind energy) in Saxony, Germany which was founded to respond to citizens' protests. It includes supporters and opponents of wind energy, regional planners and the region's district office [170]. Top-down formats were most frequently found to have a negative effect [56,108,128,146,147,161,162,164,192], followed by a mixed effect [114,127,129,132,136,170,185], and an unclear effect [110,117–119,148,173]. Only three studies identified a positive effect [123,139,142].

Bottom-up participation was coded less often than top-down participation (33 times). Bottom-up participation was mostly instigated by citizen initiatives [145,154,169,193,195,205], interest groups and local newspapers [206], protesters [194], and scientists [125]. At the same time, citizens and citizen initiatives are also the target groups [133,169, 189,207]. Citizen initiatives are of especial interest since they enjoy particularly high levels of trust and can therefore promote greater acceptance [137].

It is emphasized that "[t]raditional top-down decision-making processes are no longer unquestioned and citizens expect to participate in decision-making processes" ([197], p. 128). Bottom-up formats include citizens' forums, future workshops [184], dialogue formats [184,189], petitions [205], organized interest representation [208], direct democratic formats like referenda, and participative governance like climate protection boards [126]. Financial participation is included as well (see below) [137,209], such as citizens' energy cooperatives (*Bürgerenergiegenossenschaften*) [204] and citizen wind farms [137].

Protests can also be seen as a kind of bottom-up participation [184, 194,200,209,210]. In one example, protests in Saxony, in combination with other factors, made the government readjust its energy and climate policy and led "to a slowdown of energy-related landscape change" ([194], p. 1). Local protests are able not only to slow down projects but also to stop them [153]. The most common effect for bottom-up participation is one that is both positive and negative [115,125,126, 133,137,153,176,186,189,195,211], followed by an unclear effect [174, 208–210,212]. Positive [166,197] and negative effects [154,207] were each found only twice.

The category *standards of participation practice* was coded 48 times. The most frequently mentioned standard was transparency [117,118, 120,121,126,131,132,135,137,143,152,157,159,168], followed by fairness [117,126,134,137,157,184,187,198,200,213,214], which has the potential to increase acceptance [187] and avoid conflicts [214].

Other standards concern the way information is transmitted. The language should be comprehensible and easy to understand [112,117, 118,139], and information should be accessible [135,157], relevant [159], independent [157], transparent, professional [152], and include different arguments [130]. Communication is thus an important factor in participation as well [122,126,132,157,215].

Another important aspect is early participation and information [117,120,125,130,135,152,211]. This enables future consumer behavior to be integrated directly into the process [211], and it makes "it possible to intensively prepare numerous topics, which would otherwise be the subject of the regional planning procedure" ([130], p. 8).

Further standards for public participation processes that were brought up more than once include trust [111,117,120,121,126], legitimacy [117,134,159,198], participation and communication on an equal footing [118,125,132,135], consideration of various stakeholders [117,209,213,215], efficiency [134,198,213], and openness [132,184, 198]; external moderators that are neutral, independent, and professional [117,120,152,198]; competency [134,198], deliberation [116, 132], an active role by citizens [135,152], neutrality [118,131], and self-determination and self-efficacy/decision-making power [111,120, 137,182].

Financial participation was coded 23 times. Examples of financial participation include citizen energy concepts [126] and community energy systems [216]. In a questionnaire conducted in Ref. [127], citizens also showed a preference for investment models. Factors influencing whether citizens participate in community energy systems include trust in the community, resistance by the community, environmental concerns, energy-related education, and awareness of financial participation [216].

There is no clarity about the effects of financial participation and more research is needed [137]. This is reflected in the coded papers: whereas most papers find both negative and positive effects [6,42,111, 126,127,135,137,186,203], and four papers find a positive effect [121, 141,166,216], the effect described in four papers is unclear [113,132, 151,209]. Some authors believe that financial participation could raise acceptance [111,135,141,151,191,193]. When people expect economic benefits, support is more likely [6] because burdens can be compensated by reciprocal benefits [135]. Additionally, local financial input can instill a sense of ownership and commitment to the project while managing varied interests [186]. Some papers also identify problems with financial participation, such as unfair distribution that can hinder participation [111], lacking or unsatisfactory commitment to compensation [132], and large, high-risk short-term investments – although these could be outweighed by the prospect of future gains [6].

Management and prevention of conflicts was coded 31 times. These papers study, for example, the relationship between public participation, conflicts, and legitimacy [121,126,129,142,147,148,207,213]. Conflicts can be a barrier to legitimacy [204], but participation can help to avoid legitimacy deficits [138]. Thus, participation has the potential to increase acceptance [121] and avoid and resolve conflicts [126,148, 213], although there may also be attempts to prevent conflicts through manipulation [174].

There are different ways to conceptualize conflicts in energy transitions [148]. divides conflicts into four levels that follow on from one another, namely the individual level, the level of citizen initiatives, the media level, and the polarization level. With a focus on decentralized energy systems, conflict types found by Ref. [125] are conflicts of interest, conflicts of distribution, conflicts of values, cognitive and affective conflicts, and normative and evaluative conflicts. Conflicts can have three results: the project is implemented without agreement; the project

is implemented with a compromise; or the conflict is prevented [173]. One issue is that these conflict studies "tend to overlook the conflict's broader context and reduce the reasons behind the protests to a defense of local interests" ([133], p. 1) when in reality, protests can have a constructive dimension [133].

Another major topic is the prevention or reduction of conflicts. Various factors are named, mostly related to the characteristics of the participation process, such as transparency [110], openness, fairness, accessibility [207], professional communication, comprehensibility, expanding participation opportunities, offering visualization and simulations [148], combining scientific expertise with ethical and moral considerations, combining online and face-to-face procedures [213], and having sufficient resources [164]. Citizens need to be heard and taken seriously, and all participants need to have the opportunity to voice their arguments [148,207]. Furthermore, it is important to detect conflicts early in order to be able to take them into account in the planning process [110].

The analysis reveals that top-down participation, while more common, often leads to mixed or negative outcomes due to its more passive involvement of the public and perceived lack of influence by citizens (see overview in Table 8). Bottom-up participation, driven by citizen initiatives and grassroots movements, has more potential for fostering trust and acceptance, although its effects can also be varied. The importance of transparency, fairness, and early involvement emerges as crucial across both approaches. These findings underscore the need for well-designed participation processes that balance both top-down and bottom-up elements, ensuring that citizens are genuinely involved and their concerns are addressed effectively in order to enhance the legitimacy and success of energy transition projects.

4.4. Evaluation of participation deficits

The evaluation of participation deficits in energy transition projects reveals several key challenges and obstacles that have been identified through empirical studies. These deficits encompass a range of issues, from general participation challenges to specific concerns related to the roles of citizens, trust in external actors, and the implementation of participatory processes (see overview in Fig. 5 and Table 9).

One significant category of participation deficits is the general negative or unclear impact of participation, which is noted 16 times across various studies [107,112,121,134,136,147,148,156,169,177,181,188,196,199,207,217]. These findings indicate that increased transparency and early involvement do not always alleviate public uncertainties regarding planning processes [156]. Additionally, there is often an inadequate link between informal and formal participation processes, with formal procedures lacking sufficient opportunities for citizen engagement [112,136]. The studies largely identify low levels of participation, ranging from mere information provision to limited consultation [112,121,134,136,147,148,156]. Many studies note both positive and negative effects of participation [107,136,169,199].

Another critical area of concern is the expression and enforcement of citizens' opinions. This issue, coded 15 times, highlights the disappointment and low acceptance among citizens when their views are not implemented through participation. This dissatisfaction arises from factors like late initiation of participation, poor accessibility of platforms, and the public administration's inability to effectively resolve conflicts. Specifically, factual participation often starts too late, when decisions have already been made at previous stages of the process, and subjective concerns like aesthetic, emotional, and personal aspects are overshadowed by other issues such as environmental and emission problems [164]. Additionally, public administration frequently lacks the resources and competence for conflict resolution, which further exacerbates the problem (ibid). These deficits sometimes lead to increased emotionalization of the participation process [130,168]. However, there are also contradictory findings regarding these negative effects. In some cases, despite their opinions not being implemented, citizens still perceive participation to have positive effects or experience a sense of self-efficacy [111,203]. By contrast, other findings reveal a general rejection of the energy transition or signs of the NIMBY ("not in my back yard") mentality [130,153,174].

The category "perception of and trust in official, external actors," coded 16 times, underscores the challenges of participation. Official, external actors here mainly refer to local politicians and authorities such as municipal councils, companies like grid suppliers, and experts such as planning institutes. Numerous studies identified a loss of trust between citizens and these official actors [108,111,113,117,137,151,152,168,203,218]. Trust in stakeholders, including how information and participation opportunities are assessed in the planning and approval process, is crucial. A lack of credibility leads to less acceptance [111], and impacts trust in the political system [215]. Concrete participation deficits that influence this trust include a lack of citizen influence in debates due to power imbalances [142,152,158,209], information from official actors that is perceived as untrustworthy [117], or suspected unfair and non-transparent practices within an official authority or company [203]. Moreover, the perception of power imbalances, where citizens' initiatives feel overpowered by authorities or companies, further deteriorates trust [158]. One study also shows that citizens feel paternalistically restricted by professional expert judgments and institutional interventions. They want to have an influence on what happens in their community, and resist processes that are perceived as paternalistic [142].

High expectations of participation, coded five times, reflect the desires and hopes citizens have for their involvement in democratic processes. However, these expectations often remain unmet, leading to disillusionment and decreased acceptance. The findings suggest that there is a need to manage expectations realistically, because if an expectation of participation is created that cannot be fulfilled, it leads to disillusionment and decreased acceptance [117,119,128,193,219]. As a result, citizens may choose to disengage, and municipal decision-makers might shy away from introducing new participatory initiatives [119].

The involvement of affected parties, coded 11 times, is another area in which deficits are evident. Several studies point out that affected communities and stakeholders are, in many cases, excluded from the discourse surrounding the planning process. They often struggle to voice their interests at the right planning stage, largely because factual participation starts too late, when decisions are already made, or subjective concerns are overshadowed by environmental and emission issues [109,161,164].

Affected communities and stakeholders wish to be better informed and more involved in the decision-making process [5,114,125], but barriers such as social inequality [126], unclear roles in informal participation processes [110], and a lack of intermediary organizations or trusted citizens [125,208] hinder their meaningful engagement. The authors of one study highlight the importance of cooperation and

Table 8
Effect of participation and participation deficits by implementation of participation.

Implementation of participation	Effect of Participation				Participation Deficits					
	Positive	Negative	Mixed	Unclear	Not specified	Persons/ roles	Implementation	Acceptance	Legal Framework	Locally relevant issues
Top-down	3	9	7	6	4	18	23	3	5	5
Bottom-up	2	2	11	5	2	11	12	3	2	6

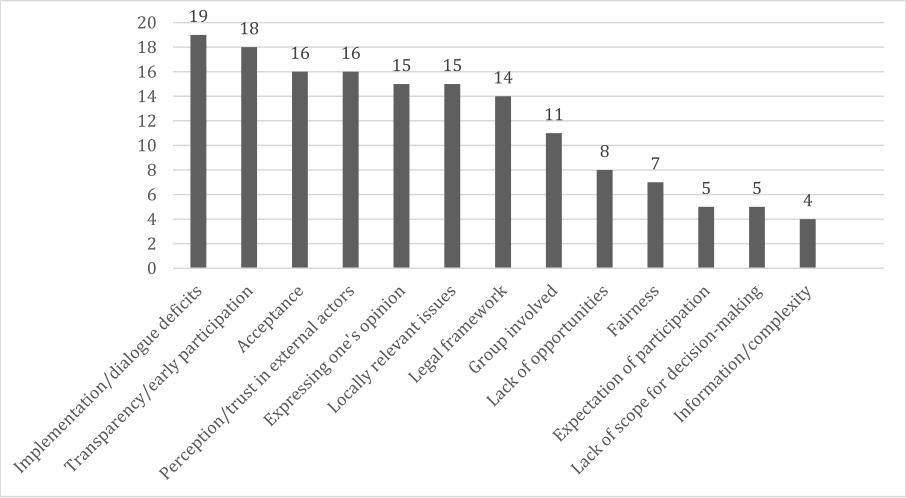

Fig. 5. Total number of participation deficits by category.

Table 9
Participation deficits by levels of citizen participation[a].

Deficits	Levels of Citizen Participation				
	Informing	Consultation	Inclusion	Empowerment	Manipulation
Not specified	7	6	4	1	1
People/Roles					
Expressing and asserting one's own opinion	5	7	3	2	2
Perception/trust in official external actors	8	5	4	1	0
Expectation of Participation	3	2	0	0	0
Group of People Involved	8	5	4	0	0
Implementation					
Lack of scope for decision-making	4	5	2	0	0
Lack of opportunities for participation/access	3	2	1	1	1
Implementation/dialogue deficits	14	11	5	2	1
Transparency and early participation	11	8	4	1	2
Fairness	3	2	2	2	0
Information/complexity	3	3	0	0	0
Acceptance	4	7	3	1	0
Legal framework for participation projects	5	7	2	0	1
Locally relevant issues/restrictions	5	6	3	1	0

[a] Note: This overview contains duplications. For example, if a single text addresses multiple categories such as *informing*, *consultation*, and *expressing* and *asserting one's own opinion*, the deficit is counted separately for each category. As a result, the total number of deficits listed here is higher than the overall number mentioned in the text.

participation on equal terms:

"They must be seen as equal partners who are certain that they will not be treated worse than the applicant. As witnesses to the proceedings, trusted citizens' representatives can help to build trust in the impartiality of the authorities." ([125], translated from German).

In addition to participation deficits, implementation deficits also feature prominently, with a total of 59 findings [42,56,109,111–119,125,126,129,130,132,135–137,139,145,146,158,159,161,164,168,170,195,196,203,205,209,214,219,220]. These include a lack of decision-making autonomy, limited participation opportunities, and significant dialogue deficits. When it comes to the first category "lack of decision-making autonomy" (coded five times), a common issue is tokenistic consultation and a perceived lack of influence on the part of participants [120,137,145]. Citizens are often invited to provide feedback, yet find that decision frameworks are inflexible, with little change occurring post-consultation [145]. There is a strong imbalance in resources, so that companies and associations dominate the decision-making landscape [119]. The perception of democratic deficits in the approval process exacerbates these problems [158]. The "lack of participation opportunities/access" category, coded eight times, refers to instances in which individuals or groups are unable to effectively engage in the decision-making process due to barriers such as limited access to information, insufficient public involvement, and ineffective participatory practices [115,164,220]. Social inequality is identified as the greatest difficulty [126]. Other findings point out that citizens generally reject "alibi participation" which has no real influence on the project [151,191].

Dialogue deficits, coded 19 times, refer to obstacles that hinder the effective engagement of participating individuals or groups in the decision-making process. Two papers highlight the critical problem of a general lack of interest in dialogue on equal terms, which undermines trust and cooperation in participatory processes [125,168]. Another obstacle is the way in which dialogue participants are selected and approached [56,126,132]. Issues include the non-representative selection of participants, such as the tendency to prioritize participants from metropolitan areas over rural ones, or not including policymakers [56]. The findings also show inconsistent methods for approaching residents [132]. Additionally, some studies highlight dialogue deficits such as mistrust in information from official sources, an information lag, language barriers, and difficulties in coordinating communication [117]. The digital divide and the lack of appropriate means of communication are also mentioned as barriers [109]. Furthermore, the formats in which participation processes are organized have a considerable influence on their effectiveness and inclusivity, and should enable an exchange of arguments [116,119,129]. Oftentimes, real participation processes do

not meet the requirements or expectations of a productive and fair dialogue, leading to more entrenched conflicts. Local conflicts become questions of moral principle instead of being resolved pragmatically [130,195]. Participation processes need to be carefully managed, as they can otherwise lead to the formation of parallel spaces in which opinions are formed outside the formal procedural framework. These spaces can then be instrumentalized by populist actors [42,219]. As an alternative, "our findings suggest that the activities of wind energy developers and operators could be complemented by more responsive and deliberative forms of participation" [42].

Transparency and early involvement, coded 18 times, are critical factors for successful participation. Two papers note a definite lack of transparency and early participation [56,116]. Both studies cover top-down participation processes, with the type and depth of participation ranging between information and consultation. One paper connects a lack of transparency with the phenomenon of citizens only demanding participation towards the end of a planning process, when the opportunities for participation are at their lowest [116]. Many other findings emphasize the important role of participation at an early stage, and of transparent information and communication throughout the participation process [42,109,111,114,115,125,136,151,170,214].

Early participation in planning processes, while essential for transparency and conflict identification, can still lead to frustration and conflicts due to the lack of concrete information in the early stages and the nature of democratic procedures [109,125]. Despite these challenges and the potential for frustration, early participation in planning processes is always preferable to appeasement, as it is the only way to build trust and meet the high demands of citizens for early information, active participation, and transparency [113,135]. It is therefore important that citizens are given a transparent explanation of their right to participate [42,112]. Transparency and early participation can counteract the perception of democratic deficits, but only if the interests of citizens are given greater consideration in the participation process [158]:

"These forms of participation should include transparent provision of information and also the possibility for citizens to state their opinions in such a way that they can be taken into account in the development and implementation of wind energy projects." [42].

Fairness in participation processes, coded seven times, is another crucial aspect. The findings provide an overview of various reasons that lead to perceived unfairness in participation processes. Non-transparency and inequitable access to information due to the digital divide, for example, were mentioned multiple times [109,114,135]. Other findings address power imbalances, for example when different villages or communities are affected to varying degrees by a project, yet each has an equal say in the decision-making process [168]. Additionally, citizens often feel powerless against profit-driven companies [209], and critics are sometimes accused of rejecting wind power on principle without serious consideration [114,168]. Imbalances of power and proceedings perceived as unfair can cause citizens to believe their participation is merely a formality, with the decision-making power remaining with higher authorities. In one case, citizens perceive participation as a process that is not meant to be taken seriously by companies because of their motive of maximizing profit. This perception is reinforced by media depictions of a "David versus Goliath" struggle [209].

The impact of information and its complexity, coded four times, also plays a significant role in participation processes. Providing information is not inherently positive and can sometimes have a negative impact on the acceptance of projects [118]. Additionally, the complexity of reading materials can make it difficult for those affected to gain an overview of all the information [139,159].

Acceptance of energy transition projects, coded 15 times, reflects citizens' and stakeholders' willingness to support and cooperate with these initiatives [115,128,131,135,137,153,157,163,183,185,189,192,215,218,221]. Local protests against energy transition projects can significantly impact the success of initiatives, potentially delaying or halting them, but are nevertheless considered relevant to the political process, rather than purely self-serving [153]. Many findings identify partially or entirely negative effects of participation, indicating that there is no certainty that increased participation will automatically result in higher social acceptance [128,137,163,185,192]. More participation can sometimes increase social protest and reduce acceptance due to information about drawbacks or unmet expectations [128,185,192], while less information might paradoxically lead to higher acceptance [163]. Multiple studies show that if the necessity of grid expansion is doubted, participation does not lead to an increase in acceptance or compromises [135,189,218]. It is therefore emphasized that acceptance in and of itself should not be the goal of participation processes [157,189]. In some cases, individual factors that have been proven to influence acceptance were investigated, such as the acceptability of underground cables compared to overhead lines or personal attitudes towards life satisfaction, climate change, and the environment [183,221].

The legal framework of participation projects, coded 14 times, refers to various legal and regulatory aspects that shape and influence the implementation of participation projects [9,110,113,116,117,127,152,156,165,170,175,204,208,219]. Integrating participation into the legal framework and the processes of policy and planning authorities is often described as challenging for many reasons [5,107,110,113,153,167,172]. For example, even though citizen participation is formally integrated into land use planning, it often remains informally anchored within the broader political and administrative systems [116]. There also exists a high degree of uncertainty and inflexibility among the responsible planning authorities as to how informal participation processes should be implemented and how roles should be allocated [110,170]. The participation paradox is also mentioned in this context [175]. To bridge these gaps, early participation and suitable participation formats are again mentioned repeatedly as critical factors in the success of planning and policy projects [152,156,219]. Furthermore, a collaborative approach, as opposed to a top-down, imposed decision-making process, is seen as important [127].

Locally relevant topics, coded 15 times, highlight the importance of analyzing specific situations on a local level to further reinforce the link between theory and application, as the general approval of energy transition projects by citizens can shift based on concrete local contexts [135]. Local resistance can also reveal deeper conflicts or indicate broader mistrust or a disconnect between local needs and planning processes [108,162]. Sometimes, local opposition significantly impacts planning and policy projects, leading to delays or policy adjustments [194,205]. There are many possible locally relevant topics and particularities that have to be taken into account to foster local support and advice [123], including concerns about energy transition projects affecting recreation areas and tourism [152,168], and about environmental protection [6,154]. Despite attempts to address local issues, however, many citizen concerns are often dismissed or have minimal impact on planning decisions, as one example from participation in grid expansion shows:

"The decisive observation, however, is that the interests and concerns expressed by the private public in the comments were for the most part irrelevant to the respective procedural step. For example, most of the comments submitted during the consultations on demand planning to date contained objections to the fundamental decision to expand the electricity grid or objected to specific expansion projects." ([222] translated from German)

In summary, the evaluation of participation deficits in energy transition projects reveals a complex array of challenges that hinder effective public engagement. These deficits range from general participation issues to specific concerns related to citizens' roles, trust in external actors, fairness, and legal frameworks. Addressing these challenges is crucial for enhancing the legitimacy and effectiveness of participation processes in energy transitions.

4.5. A comparative analysis: cross-cutting insights between the different dimensions of public participation

Public participation in energy transitions has been studied extensively, with various levels of citizen involvement, conditions, and impacts identified. This analysis focuses on comparing key dimensions of participation (informing, consultation, inclusion, empowerment, and manipulation) and their outcomes across different contexts.

4.5.1. Levels of citizen participation

- Informing and consultation are the most prevalent forms across studies, suggesting a default reliance on these lower levels of participation due to their cost-effectiveness and scalability. However, their mixed results in fostering acceptance and legitimacy indicate limitations. For example:
- Positive outcomes in building trust and transparency were reported when early and continuous information was provided in comprehensible formats (e.g., websites, flyers, public forums).
- Negative outcomes stemmed from one-sided or overly complex information, creating perceptions of manipulation and increasing public skepticism.
- Consultation's success varied by format, with dialogic forums and citizen surveys showing promise in increasing feedback while round tables often struggled to represent diverse voices effectively.

Inclusion and empowerment, though less frequent, appear to be more transformative, fostering co-production and co-decision-making. For instance.

- Empowerment processes, such as referenda in Switzerland, allowed for a more democratic decision-making framework, leading to higher project acceptance.
- Mixed results in inclusion emphasize the need for tailored formats like advisory boards or citizen juries that actively engage diverse stakeholders.

4.5.2. Conditionalities of participation

- The design and timing of participatory processes are critical for success. Early involvement combined with transparent mechanisms increases acceptance and reduces conflicts. However, late-stage participation tends to aggravate distrust and protests, as evidenced by grid expansion projects in which public input was often sought after significant decisions had been made.
- Trust in external actors: A recurring theme is the erosion of trust in political and corporate actors, particularly when participation is perceived as tokenistic. Grassroots and bottom-up initiatives are seen as more trustworthy and effective in bridging this gap.
- Contextual factors: Locally specific issues, such as visual and environmental impacts, significantly influence participation success. Renewable energy projects in rural areas, for example, face unique challenges due to their potential disruption of landscapes and livelihoods.

4.5.3. Effects on acceptance and legitimacy

- The role of participation in building acceptance is nuanced. While increased participation often correlates with higher acceptance levels, excessive or poorly managed participation can backfire, creating dissatisfaction and resistance. For instance:
- Excessive information regarding project risks heightened public fears in certain contexts, whereas limited but clear information maintained optimism and support.
- Procedural fairness, including equal access and transparency, was pivotal in achieving perceived legitimacy, regardless of the participatory level.

Legitimacy emerges as a central outcome of effective participation, shaped by input (inclusiveness), throughput (procedural quality), and output (decision quality). Studies highlight that legitimacy depends not just on participation formats but also on their alignment with local norms and expectations.

4.5.4. Deficits and challenges in participation

- Persistent deficits include limited decision-making power, poor communication, and accessibility issues. Social inequalities often restrict effective participation, as noted in cases in which digital platforms excluded older or less tech-savvy demographics.
- The mismatch between citizen expectations and actual influence leads to disillusionment. For example, many participants felt their input was disregarded in formal consultation processes, reducing trust in institutional mechanisms.
- Conflict management: Effective mechanisms for resolving conflicts were found in participatory processes that combined face-to-face deliberations with digital tools, fostering inclusive dialogue. However, in several studies, unresolved disputes escalated into protests, delaying or derailing projects.

4.5.5. Comparative insights: top-down vs. bottom-up approaches

- Top-down participation: Frequently mandated by legal frameworks, these processes often involve informing and consulting. While necessary for large-scale projects, they are criticized for their rigidity and inability to address local concerns adequately.
- Successful examples: German grid expansion projects incorporating iterative feedback mechanisms.
- Challenges: Limited adaptability and lack of citizen empowerment.
- Bottom-up participation: Driven by local initiatives, these processes prioritize community-specific needs and democratic involvement. They often succeed in fostering trust and acceptance but face resource and scalability challenges.
- Successful examples: Citizen energy cooperatives in Germany, fostering financial and emotional investment in projects.
- Challenges: Dependency on local capacities and alignment with broader policy frameworks.

4.5.6. Cross-sectoral and energy-type comparisons

- Participation practices vary significantly across energy types. For instance:
- Wind energy projects: Face the most local resistance due to visual and environmental impacts but benefit from inclusive and dialogic participation formats.
- Grid expansion: Predominantly top-down with mixed outcomes, emphasizing the importance of early consultation.
- Community energy initiatives: Exemplify bottom-up success, with high levels of trust and local acceptance.

By addressing these dimensions through inclusive energy transition policies, participatory processes can better contribute to the successful implementation of energy facilities, what the author will discuss within the next chapter in detail.

5. Discussion

The literature review and evaluation of participation deficits in energy transition projects reveals significant challenges and obstacles, reflecting a broader concern regarding the effectiveness of participatory

processes in achieving their intended goals. Financial participation and empowerment – the most inclusive of the five levels of citizen participation – are the only types of participation in which no studies found a purely negative effect. This indicates the potential these types have for successful public participation. However, for no participation type were the results wholly positive, suggesting that there is much room for improvement when it comes to public participation procedures.

When looking at the energy forms and the effects of participation, it is noteworthy that studies focusing on energy transition infrastructure generally see a more positive effect from participation, while studies that examine specific energy types have more mixed findings. One reason for this could be that the former often take a larger-scale perspective, whereas the latter more often focus on specific case studies. This shows that it is important to work with specific cases so that the real consequences of participation can be explored [223].

Three aspects emerge as the crucial essence of this review. First, our findings suggest that more negative effects were found for top-down participation formats than for bottom-up formats. Combining both formats did not lead to clear positive or negative results. Participation deficits can be found in both formats. For top-down participation, the most frequently identified deficits were dialogue deficits (9 times), the parties involved (5 times), and perception of and trust in official external actors (4 times). For bottom-up participation, the most frequently identified deficits were locally relevant topics (5 times), acceptance (3 times), transparency and early participation (3 times) [115,125,205], the parties involved (3 times), and dialogue deficits (3 times) (see overview in Table 10).

Second, the most common participation procedures seem to be the most problematic. In terms of specific participation types, consultation shows the most frequent deficits, with dialogue deficits (14 times), transparency and early participation (12 times), and involved parties (8 times) mentioned. Informing is another participation type with significant deficits, particularly in terms of dialogue deficits (10 times), transparency and early participation (9 times), expression and enforcement of one's own opinion (7 times), acceptance (7 times), and legal framework (7 times). Regarding involvement, the most frequently identified deficits include dialogue deficits (5 times), perception of and trust in official external actors (4 times), transparency and early participation (4 times), and involved parties (4 times). In the empowerment category, deficits are noted regarding expression and enforcement of one's own opinion (2 times), and dialogue deficits (2 times). In the manipulation category, expression and enforcement of one's own opinion (2 times) and transparency and early participation (2 times) are the most frequently observed deficits. While participation in energy transitions is thus not exactly a hotbed for non-democratic practices, neither is it a perfect role model for ideal public participation in most cases. Energy participation appears to be of average democratic quality within the scope of infrastructure planning and implementation.

Table 11 highlights general participation-related deficits, emphasizing issues such as low levels of engagement and tokenistic consultations. For instance, many participatory processes are limited to providing information or collecting feedback, without meaningful opportunities for public influence. This lack of inclusivity and transparency frequently results in frustration, mistrust, and feelings of exclusion among citizens. Additionally, participation often begins too late in the process, leaving little room for meaningful input. Specific examples include delayed citizen engagement in regional planning and the complexity of the information provided, which can further alienate participants.

Lastly, the author observes the remarkable ambivalent phenomenon that while transparent and early participation and more inclusive levels of citizen participation are generally described as having positive effects, they can also have contradictory effects. The level of information provided, for example, often has both positive and negative effects ("positive if well implemented, negative if not") [152]. This means that increased participation does not always lead to higher acceptance and can sometimes result in greater social protest, especially if expectations are not met or drawbacks are highlighted [224,225].

Table 12 elaborates on implementation-related deficits, pointing to systemic challenges that hinder effective engagement. Citizens often struggle to express and enforce their opinions due to inflexible decision-making frameworks and insufficient mechanisms for integrating public input. For instance, in cases of wind energy siting, citizen concerns about local impacts such as landscape aesthetics and noise pollution are frequently dismissed, reinforcing perceptions of democratic deficits. Trust in official actors, including government agencies and project developers, is undermined by perceived unfair practices, such as biased consultations or lack of transparency in planning decisions. These shortcomings contribute to the erosion of trust and legitimacy, as highlighted in studies documenting community dissatisfaction with energy infrastructure projects.

Altogether, these findings emphasize the critical need for improvements in how participation processes are designed and implemented in energy transition projects. The potential benefits of participation, such as enhancing acceptance and reducing opposition, are not fully realized under current practices, a fact that has been well known in research for a long time [226]. To realize these benefits, addressing the identified deficits – especially those related to dialogue, trust, transparency, and the involvement of all relevant stakeholders – remains the most essential task for all institutions and stakeholders involved in participation procedures [52,227].

Furthermore, this research highlights the fact that the legal framework for participation projects significantly influences the effectiveness of these processes. Integrating participation into legal and regulatory structures presents various challenges, particularly in terms of ensuring that participatory processes are not just formally included but are also effectively anchored within broader political and administrative systems [228,229].

Procedural justice, which emphasizes fairness in the processes that lead to just outcomes, is pivotal for effective public participation in energy transitions. The reviewed studies highlight several dimensions of procedural justice, such as transparency, inclusiveness, and trust, and how they shape public attitudes, acceptance, and engagement.

First, transparency and early involvement are repeatedly identified

Table 10
Empirical results on effects of participation procedures.

Top-down participation formats	Bottom-up participation formats	Informing	Consultation	Inclusion	Empowerment	Manipulation
Dialogue deficits	Locally relevant topics	Dialogue deficits	Dialogue deficits	Dialogue deficits	Expression and enforcement of one's own opinion	Expression and enforcement of one's own opinion
Parties involved	Acceptance	Transparency and early participation	Transparency and early participation	Parties involved	Dialogue deficits	Transparency and early participation
Perception of and trust in official external actors	Dialogue deficits	Acceptance	Parties involved	Perception of and trust in official external actors		

Table 11
Empirical results on evaluation of participation deficits with respect to the dimensions of public participation.

Negative or unclear impact of participation	Expression and enforcement of citizens' opinions	Perception of and trust in official, external actors	High expectations of participation	Involvement of affected parties	Lack of decision-making authority	Locally relevant topics
Inadequate link between informal and formal participation processes	Disappointment and low acceptance when views are not implemented	Loss of trust decreases acceptance	Unmet expectation leading to disillusionment and decreased acceptance	Struggle to voice interests at the right stage	Tokenistic consultation and perceived lack of influence	Approval can shift based on local contexts
Low levels of participation (mainly informing)	Disaffection from late initiation, poor accessibility and resolution of conflicts	Impacts trust in the political system	Need to manage expectations realistically	Affected actors wish to be better informed and more involved but barriers hinder them	Decision frameworks seen as inflexible	Local resistance reveals deeper conflicts
Limited effects of increased transparency and early involvement	Subjective concerns get overshadowed	Information from official actors perceived as untrustworthy		Importance of cooperation	mbalance in resources	Citizen concerns are often dismissed but can also impact planning
	Increased emotionalization	Perception of power imbalances deteriorates trust			Perception of democratic deficits exacerbates problems	

Table 12
Empirical results on aspects of participation deficits in detail.

Lack of participation opportunities and access	Dialogue deficits	Transparency and early involvement	Fairness in participation processes	information and its complexity	Acceptance of energy transition projects	Legal framework of participation projects
Actors unable to effectively engage due to barriers like limited access to information, insufficient public involvement, ineffective practices	Unequal dialogue undermines trust and cooperation and can lead to more conflicts	Often found in top-down participation processes	Perceived unfairness because of non-transparency, inequitable access to information, power imbalances	Providing information can have negative impact on acceptance	Affects actors' willingness to support and cooperate	Influences implementation
Social inequality is the greatest difficulty	Various issues: non-representative selection, mistrust in information, digital divide etc.	Opportunities for participation are the lowest towards the end of the process	Citizens believe it is just a formality with no decision-making power	Complexity of reading materials makes it difficult to gain an overview	No certainty that increased participation will result in higher acceptance	Integrating participation into legal framework is challenging
Citizens reject alibi participation	Formats influence effectiveness and inclusivity	Early participation can still lead to conflicts but is preferable	Reinforced by media depictions		Acceptance should not be the goal	Participation often remains informal
					Individual factors influence acceptance	High degree of uncertainty and inflexibility among authorities

as critical for fostering trust and mitigating conflicts. Transparency allows communities to engage constructively, as seen in examples of regional planning processes that prioritize trust-building through early public involvement. However, deficits in transparency—such as when participation begins too late or when information is complex or unclear—can lead to frustration, mistrust, and even protests. In such cases, citizens feel excluded from meaningful engagement, undermining the legitimacy of the process.

Second, inclusiveness and representation are essential aspects of procedural justice. Dialogue-oriented approaches like citizen forums, round tables, and planning cells demonstrate how diverse voices can be incorporated into decision-making. For example, co-design workshops allow citizens to contribute local knowledge, enhancing both the process and its perceived fairness. However, studies also reveal imbalances, such as the tendency to exclude rural participants in favor of metropolitan residents, further emphasizing the need for equitable representation.

Third, fairness in power dynamics is crucial for procedural justice. Addressing power imbalances between citizens, authorities, and corporations is necessary to avoid perceptions of tokenistic consultations and decision-making dominated by profit-driven entities. Such dynamics reinforce feelings of disenfranchisement among citizens, often described as "alibi participation." Ensuring fairness involves creating opportunities for citizens to exert real influence, which can counteract perceptions of paternalism and foster procedural justice.

Fourth, trust and legitimacy are essential for the success of participatory processes. Studies demonstrate that when citizens perceive participatory processes as biased or influenced by power asymmetries, trust erodes, thus further reducing the effectiveness of participation. Several case studies highlight that biased or superficial participation erodes trust, reducing acceptance and effectiveness. For instance, the 2020 Local Energy Consulting survey highlights how distrust in planning processes and perceived lack of credibility undermine acceptance [111]. Similarly, Langer et al. emphasize that "alibi participation" fosters distrust and perceptions of injustice [151]. In contrast, initiatives like citizen energy cooperatives demonstrate how genuine financial participation builds trust and ownership, aligning procedural justice with community interests and fostering more effective engagement.

Fifth, balancing top-down and bottom-up approaches is a critical component of procedural justice. Top-down strategies, though common, are often criticized for being passive and ineffective at addressing citizens' concerns. Bottom-up approaches, such as citizen-led initiatives and protests, offer a more empowering alternative, fostering procedural justice through grassroots engagement. For instance, citizen protests in Saxony not only influenced regional energy policies but also

underscored the constructive potential of participatory resistance.

Finally, addressing procedural participation deficits is essential to advancing procedural justice. The review underscores several deficits, such as limited decision-making power, inaccessible participation opportunities, and inadequate linkage between informal and formal processes. For example, several studies on public participation in grid expansion planning procedures highlight how citizen feedback often has no impact on decision-making, fueling perceptions of democratic deficits. Addressing these deficits requires designing participatory processes that prioritize fairness, accessibility, and responsiveness.

The empirical findings further illustrate that local context plays a pivotal role in shaping procedural justice in wind energy planning. Specific examples highlight how fairness and inclusiveness can influence community perceptions and acceptance. For instance, participatory processes that incorporate local cultural values, aesthetic concerns, and regional economic priorities are more likely to gain community support. When such considerations are neglected, the likelihood of opposition increases, particularly in rural or environmentally sensitive areas in which attachment to the local landscape is stronger.

A recurring theme in the findings is the importance of meaningful inclusion of local knowledge. For example, some studies report that projects incorporating citizen advisory boards or local planning workshops significantly improved perceptions of fairness and transparency. These mechanisms allowed residents to voice concerns about visual impact, noise pollution, or environmental risks, fostering a sense of ownership over the outcomes. Conversely, when local concerns were sidelined—such as in instances of unilateral decision-making or insufficient consultation—communities often mobilized in protest, resulting in delays or even project cancellations. Another critical insight is the role of economic considerations. In some cases, community support was contingent on visible local benefits, such as job creation or shared financial gains through co-ownership models. Where such opportunities were absent, skepticism toward the project grew, especially when combined with perceived inequities in decision-making processes. Moreover, findings reveal that procedural justice in local contexts often hinges on the timing of engagement. Early and continuous involvement is particularly valued, as late-stage consultations are viewed as tokenistic and exacerbate mistrust. In some cases, protests emerged due to the perception that local voices were only solicited after key decisions had been made, reinforcing a sense of exclusion.

These examples emphasize that understanding and addressing local context in participatory processes is not merely an accessory to procedural justice but a cornerstone of it. Policymakers must design participatory frameworks that genuinely reflect the specific needs and values of local communities while balancing broader national and regional objectives.

An essential aspect of procedural justice is the careful design of participatory processes to ensure fairness, transparency, and inclusiveness. Specifically, the involvement of citizens must not only be timely but also substantive, allowing them to influence decision-making processes meaningfully. For example, informal participation methods, while often used in local energy planning, tend to focus on procedural acceptance rather than the acceptance of the project's outcome. This "participation paradox" arises when citizens are engaged too late in the process or only superficially, leading to frustration and undermining the legitimacy of the process [132].

The empirical findings confirm the significant role of procedural justice in fostering active acceptance, especially when paired with distributional justice and considerations of environmental and aesthetic impacts [120,141,219]. Studies show that active acceptance is statistically correlated with higher levels of procedural and distributional justice, with citizens more likely to support projects that they perceive as fair and just [120]. This finding underscores the importance of designing participatory processes that address both procedural fairness and the distribution of benefits ("procedural participation" [141]). Furthermore, procedural justice can help mitigate opposition to energy projects, especially when the process is perceived as inclusive and when local concerns—such as visual and environmental impacts—are adequately addressed.

Additionally, the design of participation formats plays a pivotal role in shaping perceptions of fairness. Well-structured, inclusive formats like citizen advisory boards and planning workshops not only improve transparency but also enhance the sense of ownership over the decision-making process. In contrast, carelessly designed participation processes, in which citizens feel their concerns are ignored or merely in a token-like fashion addressed, often lead to protests and a sense of exclusion, serving as a door-opener for populist actors [219]. Therefore, policymakers must carefully consider the specific needs and values of local communities, integrating these into the participatory process, to ensure that fairness and legitimacy are not only achieved but also perceived by the public.

However, while there is broad agreement that the effectiveness of participation formats hinges on their design and implementation, the most inclusive and democratically robust approaches remain the least applied in practice. Building on the overview at the end of Chapter 2, the findings highlight that top-down formats, such as information events, public announcements, and organized dialogues, are the most widely used but face significant criticism for their limited inclusivity and impact (see Image 1). These formats often fail to address core procedural justice deficits, such as local recognition and genuine involvement, which leads to perceptions of tokenism and mistrust among citizens. For example, one study notes that public consultations, while offering feedback opportunities, are often perceived as a formality rather than meaningful engagement [145].

In contrast, bottom-up formats, including citizen workshops and forums, exhibit greater potential for fostering grassroots engagement and empowering local communities. When structured to include diverse voices and local knowledge, these formats can build a sense of ownership and trust in decision-making processes. For instance, citizen-driven forums that integrate local environmental and aesthetic concerns have shown a significant capacity to increase acceptance of renewable energy projects. Despite their potential, these formats are less frequently implemented, often due to resource constraints or institutional inertia. Community energy initiatives, often driven by grassroots participation, represent a promising avenue for empowering local stakeholders and fostering ownership over energy projects. These initiatives have demonstrated the potential to improve the robustness and integrity of energy systems through localized efforts [211]. However, the impact of such projects tends to be geographically limited, with challenges in translating grassroots innovations into mainstream policy frameworks [208]. Empowerment through community energy also requires sustained engagement and resources to ensure equitable participation and long-term viability.

Collaborative formats, such as planning cells, represent a middle ground, combining elements of both top-down and bottom-up approaches to bridge gaps between authorities and local stakeholders. These methods allow for integrating diverse perspectives, offering a structured yet inclusive platform for deliberation. Empirical findings indicate that planning cells not only improve the perceived fairness of processes but also enhance their legitimacy by mediating conflicting interests. Their relative rarity in practice, however, limits their broader applicability despite their proven effectiveness. In regional energy planning, incremental and iterative approaches are emerging as effective strategies for addressing the complexities of energy transitions. These methods emphasize step-by-step consultations and evaluations, enabling a nuanced consideration of plural values, interests, and uncertainties [159,211]. This process not only enhances the inclusivity and fairness of decision-making but also aligns energy planning with regional needs and preferences. Additionally, a focus on analytic-deliberative discourse—combining expert knowledge with public input—has proven effective in identifying knowledge gaps and avoiding distortions in decision-making [211].

Image 1. Joint findings on participation formats in energy transitions.

Finally, co-creative formats like focus groups and co-design workshops emphasize shared problem-solving and the collaborative development of solutions. These innovative approaches, though sporadically applied, demonstrate significant potential for fostering cooperative decision-making and resolving disputes. For example, co-design processes that incorporate local place-based values into project planning have been particularly effective in addressing conflicts over the siting of wind energy infrastructure. Such formats exemplify the potential of participatory mechanisms to align national energy goals with local community interests, achieving both procedural justice and sustainable outcomes. Co-creative approaches are increasingly recognized for their capacity to generate socially innovative solutions and address conflicts in energy transitions. Effective co-design processes require inclusive participation, iterative dialogue, and the commitment of all stakeholders to collaboratively shape decisions. Research highlights that co-creation fosters perceived fairness and ensures that solutions reflect the diverse needs and values of affected communities [166,175]. Moreover, co-production of knowledge through these processes can enhance local social innovation and resilience [167]. For instance, co-design workshops have been instrumental in integrating local environmental and aesthetic concerns into planning, fostering greater acceptance of renewable energy projects.

6. Current challenges and future research perspectives

The findings highlight the importance of designing participation processes that combine top-down and bottom-up approaches. Emphasizing fairness, transparency, and early involvement while accommodating local contexts and specific energy types can enhance the legitimacy and acceptance of energy transition projects. Future participatory frameworks should focus on, first, bridging the gap between formal and informal processes; second, strengthening trust in external actors through accountability and inclusivity; and third, tailoring participation formats to the socio-demographic and contextual realities of the affected communities.

The findings summarized in Table 13 provide key insights into the levels of inclusion in participatory processes, highlighting both their effectiveness and common deficits through notable examples. Information provision, often considered the first step in participatory processes, can be either formal or informal. Early dissemination is critical for building trust and transparency, but significant deficits arise when opportunities for active participation are missing. For instance, in a German village, information sessions about wind power projects allowed for questions but did not engage citizens in active decision-making. Consultation, a frequently employed format, encompasses both formal and informal approaches and is foundational for effective participation. However, this level often suffers from common deficits, such as limited stakeholder engagement. A working group in another case study from Germany exemplifies informal consultation by involving stakeholders in discussions but offering limited decision-making influence.

Direct involvement of citizens and communities enhances the acceptance of goals when broadly supported, making mechanisms like co-production and co-design critical at this level. For example, Energy Labs established across ten European communities under the Interreg Europe project enabled local actors to contribute to energy transition plans. Empowerment through co-decision-making has been associated with positive outcomes, such as increased support and higher-quality planning processes. Notable examples include a Energy Village in Germany, in which the community actively collaborated on renewable energy project decisions. Similarly, the *Energy Atelier Friesland* in the Netherlands allowed local communities to design their processes, while the *Ailes des Cretes* wind farm in France used innovative measures, such as financial benefit sharing and enabling citizen investment, to enhance engagement. These examples underscore the varying impacts of participatory approaches and highlight the importance of moving beyond tokenistic consultation to more inclusive and empowering formats.

This review unfolded several notable challenges of public participation, as summarized in Table 14. A key issue is the exclusion of affected actors, often due to late involvement or limited participation opportunities, which can be addressed through early and continuous engagement. Transparency and fairness deficits in processes lead to perceptions of distrust and unfairness, necessitating improved communication and transparency efforts. Many participants feel disempowered

Table 13
Most important findings on levels of inclusion and typical examples.

Level of inclusion	Findings	Examples
Information	Often listed as the first step	Wind power in *Engelsbrand* (Germany): provision of information and possibility for questions opportunities but not active participation [153]
	Formal or informal	
	Importance of early information, can create trust and transparency	
	Significant deficits	
Consultation	Both formal and informal	Wind power in *Meißen* and *Sächsische Schweiz* (Germany): Informal consultation with different stakeholders in the form of a working group [108]
	Seen as an important basis for participation	
	Can include many different stakeholders	
	Most common and most frequent deficits	
Involvement	Formal and informal	Energy Labs in ten different European communities as part of the project *Interreg Europe* [144]
	Important that citizens and communities participate directly	
	When goals are supported by a wide range of citizens, they are more likely accepted	
	Co-production and co-design	
Empowerment	Co-decision-making is also possible	RE projects in Energy Village *Wildpoldsried* (Germany): Local community played a key role in implementing the RE concept and all important decisions about location, type of energy etc. were made in cooperation with them [115].
	Positive effects: more support for the project and a higher-quality planning process	*Energy Atelier Friesland* (Netherlands): Experimental, community-driven initiative that sought to allow communities to design their own processes [115].
	No study finds a purely negative effect	Wind farm in *Ailes des Cretes* (France): Usage of innovative participation measures, like sharing financial benefits and helping citizens to invest in the project [115].

Table 14
Challenges of and chances for participation procedures.

Participatory deficit	Method of resolution
Affected actors do not feel included, late involvement, lack of participation opportunities	Mandate early and continuous involvement
Participation is perceived as unfair, lack of transparency	Enhance transparency and communication
Lack of decision-making authority	Empower citizens in decision-making
Participation is not sufficiently integrated into legal frameworks	Integrate participation into legal and institutional frameworks
Participants do not trust official actors; participants do not see their voices heard, inadequate dialogue procedures	Address power imbalances and social inequality
Low Acceptance	Develop and implement best practices for participation
Negative or unclear impact of participation	Learn from deficits in participation in energy transitions
Lack of decision-making authority, low acceptance	Ensure meaningful participation rather than tokenism
Conflicts concerning local topics	Tailor participation processes to local contexts
Affected actors do not feel included	Foster continuous learning and adaptation

due to a lack of decision-making authority, highlighting the need to empower citizens in decision-making and integrate participation processes into legal frameworks. Trust issues with official actors, inadequate dialogue procedures, and power imbalances further undermine participation, calling for measures to address social inequalities and ensure that participants feel heard. Low acceptance of projects remains a pervasive issue, which can be tackled by developing best practices for participatory processes and tailoring these to local contexts. Resolving local conflicts and ensuring meaningful involvement, rather than tokenistic engagement, are critical for improving acceptance and effectiveness. Lastly, fostering continuous learning and adaptation within participation frameworks is essential to address evolving challenges and ensure robust engagement outcomes.

Promising examples for improving public participation in energy transitions are as follows. First, mechanisms like energy labs have shown potential to empower stakeholders by fostering collaboration and creating a space for experimentation and learning [144,167]. Empowerment can also be tested through approaches such as spatial citizenship, which enable stakeholders to actively shape decision-making processes by linking local knowledge with participatory tools [169]. Second, strategies against manipulation, misinformation, and populism are critical to maintaining the legitimacy of participation projects. These projects are particularly vulnerable to populist agitation, which can distort discussions and undermine outcomes. Timely and carefully designed participatory processes are essential to preempt such risks and ensure meaningful engagement [219]. Third, integrating top-down and bottom-up procedures is increasingly recognized as a strategy to enhance the inclusivity and effectiveness of participation. Many processes feature a combination of passive public actors—engaged through top-down information dissemination—and active public actors, who influence decisions via grassroots initiatives and deliberative forums [203]. This merging of approaches can create a more balanced and adaptive participatory framework.

The energy transition in Europe, particularly in Germany, Austria, and Switzerland, faces significant challenges despite numerous proposals for public participation and governance frameworks. While participation is a key aspect of achieving procedural justice and ensuring successful energy transition projects, organizing effective and inclusive

processes remains a practical challenge [230].

In Germany, the implementation of municipal heating planning exemplifies the complexity of balancing local concerns with overarching national goals. While early information dissemination and local involvement are encouraged, practical deficits persist. Late-stage public consultations often result in perceptions of tokenism, which leads citizens to feel excluded from meaningful decision-making processes [37,230]. For example, renewable energy siting processes have highlighted tensions between local resistance (NIMBY effects) and national decarbonization objectives [231].

In Austria, the energy transition focuses on expanding renewable energy, particularly photovoltaics (PV) and battery storage systems. Austria aims to cover 100 % of its energy consumption from renewables by 2030, but challenges include bureaucratic permitting procedures and limited public involvement in spatial planning processes. Although innovative formats, such as participatory energy labs, show promise in empowering local stakeholders, their application remains sporadic due to resource and institutional constraints.

In Switzerland, the participatory landscape mirrors broader European trends. Local communities often express distrust towards official actors and project developers due to a lack of transparency and perceived power imbalances. Moreover, reliance on top-down decision-making structures exacerbates the sense of exclusion. While co-creative processes such as citizen workshops are emerging as effective tools, they are not yet systematically integrated into planning frameworks [85,230].

At the European level, accelerating the energy transition remains a priority in response to both climate change and geopolitical concerns, such as the energy crisis following Russia's aggression against Ukraine [231]. While the European Union aims to achieve climate neutrality by 2050, challenges persist in harmonizing policy frameworks across member states. The disparity between countries with advanced renewable energy systems (e.g., Norway) and those heavily reliant on fossil fuels (e.g., Poland) underscores the need for tailored, context-specific participation strategies. In countries like Norway, in which renewable energy infrastructure is well-established, public participation often focuses on co-creation processes and community ownership of renewable projects. For example, local cooperatives play a significant role in managing hydropower plants, fostering trust and engagement through financial participation and shared benefits [230,232].

In contrast, countries like Poland, in which dependence on coal remains high, participation must address socio-economic realities, such as job security and regional economic dependency on fossil fuel industries. Community-driven initiatives, such as energy cooperatives or local pilot projects for solar and wind energy, can help transition regions gradually while ensuring local involvement. For instance, targeted programs that enable reskilling for workers in coal-dependent areas and offer financial incentives for renewable energy adoption can enhance acceptance and participation [224,233]. Tailored approaches that recognize local cultural, economic, and social contexts are critical for building trust and overcoming resistance [234,235].

Future research must comprehensively address the current gaps and challenges in participatory processes while integrating all relevant insights. Bridging formal and informal processes remains essential for fostering inclusive participation. Current evidence highlights that top-down governance structures, such as formal consultations, often fail to address local concerns effectively [37,230]. Combining these approaches with bottom-up mechanisms like citizen forums, local workshops, and co-creative processes can help incorporate diverse perspectives and improve procedural justice. Examples include participatory energy labs implemented in Austria and community-based renewable energy cooperatives in Switzerland, which empower local actors to shape energy transition projects [34].

Enhancing trust and transparency in participatory processes is another crucial research avenue. Findings suggest that a lack of clear communication and transparency fuels public distrust in energy transition projects [85,232]. Research should explore mechanisms such as transparent decision-making documentation, mandatory reporting on how public feedback is integrated, and the inclusion of independent facilitators to build credibility [48,224].

Local contexts and socio-demographic realities must be central to future research. Participation formats need to be tailored to account for urban-rural disparities, economic vulnerabilities, and cultural attitudes. For instance, in coal-reliant regions like Poland, research should focus on programs that address workforce transitions and integrate public participation into regional energy planning [231,236]. Such initiatives can include job reskilling programs, local benefit-sharing schemes, and community-led renewable energy projects [86].

Integrating digital tools and innovations into participatory processes offers significant potential for improving accessibility and engagement. Virtual platforms, energy transition simulations, and digital co-design workshops have demonstrated success in expanding participation opportunities [38,85]. Research should evaluate their long-term effectiveness, particularly in addressing digital divides and fostering meaningful, rather than tokenistic, participation [51].

Iterative and adaptive approaches to energy participation must be explored to address the dynamic nature of energy systems. Participation processes need to incorporate continuous learning mechanisms that allow for stakeholder feedback, evaluation, and adaptation over time [231,237]. Pilot projects in Austria, such as energy labs, highlight the benefits of iterative frameworks in addressing uncertainties and ensuring long-term success.

Lastly, future research must examine the intersection of procedural justice and socio-economic equity. Studies should explore how participatory processes can balance the trade-offs between efficiency and fairness, ensuring that vulnerable and marginalized communities are not left behind in the energy transition [83,224,230].

7. Conclusion

Despite the progress made, public participation in the energy transitions remains fraught with challenges, as is particularly visible in the cases of Germany, Austria, and Switzerland. Future research must focus on both evaluating and developing integrated, context-specific approaches that combine fairness, transparency, and inclusiveness. Addressing these deficits is critical for achieving procedural justice, fostering trust, and ensuring the legitimacy of energy transition projects across Europe. By embracing innovative participation formats and bridging the gap between top-down and bottom-up processes, policymakers can move closer to a truly participatory and just energy transition.

Indeed, based on the findings of the literature review in this paper, the author observes the problem described by Ref. [238] as the "delivery-democracy dilemma." According to this, the scope for public participation is shrinking, and local decision-making powers are heavily restricted. Governments attempt to depoliticize debates to implement their policies. This trade-off between effectively implementing energy transitions while ensuring "democracy without shortcuts" [239] appears to be the greatest challenge for democratic energy transitions. Both the findings of our literature review and individual contributions from research indicate that it is not only about offering participation in energy transitions but about *how* it is granted: If participation is offered merely for appearances' sake in the interest of effective and quick implementation, but no real room for influence and local preferences is allowed, then these participation formats urgently need reform [240–242]. Our findings and recent energy justice research show that considering place attachments plays a central role and that senses of place, place identities and meanings, local distinctiveness, and the genius loci (the spirit of a place) are decisive. Through a recalibrated "place-making," a new form of place satisfaction can be established that is supported by the majority of communities [233]. For this purpose, new "wider spaces of participation" must be created [232], which

enable local specifics to be calibrated with policy goals across all channels of information, access, and decision-making, as proposed by Ref. [230].

Jenkins et al. [85] found that the most frequently mentioned policy recommendations in the literature are supportive financial structures, attention to local contexts, collaborative procedure and decision-making, targeted technological investments, and widened recognition. However, they also note: "Much less are, for example, transparency, defining need versus choice, fostering cross-boundary discussions, and learning from other contexts" (ibid). Under the real-world conditions of energy transitions – consistent with the results of this review – [243] found that, beyond public hearings, other innovative participation formats are rarely used (see also [244]). They identified key challenges of participation in energy transitions (the four most emphasized being: stakeholder/public impact on decisions, timing (early/late, continuous/fragmented), information sharing and access to the process, and the range and number of stakeholders considered and invited) as well as the most important success factors and recommendations (the four most emphasized being: timing (early/late, continuous/fragmented), mechanisms (methods, tools, general communication, cooperation), involvement and participation skills, and resources (time, finances, legal advice). These findings confirm our results, highlighting challenges related to the participation process (e.g., failure of proactive planning, failure to treat participatory processes seriously, non-continuous communication, not incorporating different types of information, non-representative stakeholders, exclusion of key groups from the dialogue), process and outcome (e.g., failure to understand social dynamics in place, stakeholder frustration, arising conflicts instead of solving them, expensive and time-consuming processes), and outcomes (e.g., reinforcement of existing power inequalities, pointless if decisions are ignored, resulting in worse decisions, or "undesired outcomes of participation," in which citizen participation may lead to unsustainable solutions).

Van der Wel et al. [34, p. 2] speak in this context of the "promises of energy justice," which contrast with "real-world practice," necessitating a grounding of debates, first through a better understanding of how decision-makers consider and balance energy justice and then re-grounding in the practice of decision-making (see also [245]). Energy transition research must therefore rethink, revise, and expand the agendas for energy democracy and justice [236]. The real-world problems of implementing energy democracy must be increasingly incorporated into empirically grounded and spatially explicit analyses, as [83] demand. While acceptance studies clearly point out that procedural justice holds the key to solutions (i.e., issues of fairness, participation, and trust in local actors during the planning process influence acceptance, see Refs. [246–248], research also shows that "the majority of developers prefer that members of the public provide input but not recommend or make decisions," which is far from the "idealized vision of full citizen empowerment envisioned in narratives of just transition" [249]. Giordono et al. [250] even go so far as to suggest that "resistance to wind energy proposals is more likely to be shaped by existing processes for public participation than to shape them." Based on our comprehensive evaluations, the author believes that frustration is certainly generated among participants; however, this should serve as motivation to improve participation – because although positive examples are rarer, they do exist. Finally, it must also be considered that majorities in local communities may simply reject new energy infrastructures like wind turbines, as Webler and Tuler [38, p. 105] note: "To the project advocates, the risks may be trivial, but an on-shore community may conclude that the risks, however small, are not worth the benefits." The authors argue that top-down approaches may overcome local opposition but worsen problems, creating social distrust, unfair distribution of risk, economic inefficiencies, and social conflict, which the author can confirm (ibid). Therefore, more effective approaches to public participation are needed [237], addressing the "scalar mismatch between the interests and power of those exercising democracy at provincial/state levels and those living locally and impacted" by energy transitions [236]. Bell et al. [71,251] point to a "social gap" in wind farm siting decisions, which can also exist as an "individual gap" in which positive attitudes toward wind power in general exist, but a specific local project is rejected. To address these individual perceptions (see place attachments) and the multi-level governance problem, a broader, cross-level perspective on energy transitions is needed. Conditions on the local micro scale (e.g., disruption of ecosystems, loss of local jobs, urban-rural divide), national meso scale (increase of subsidies, inequality of benefits, increased vulnerability), and global macro scale (rising energy demand, global supply chains, labor conditions) must be more integratively considered and incorporated into energy transition planning processes [85]. Ultimately, the author agrees with the proposal to establish "wider spaces of participation" that function and are organized across levels [232].

Finally, it must also be noted that while public participation is essential for fostering acceptance, legitimacy, and community empowerment in energy transitions, it represents only a portion of the overall participatory practices observed. It is one of several approaches alongside industry-led, policy-focused, and academic engagements. This indicates that, although public participation is significant, it functions within a broader ecosystem of participatory formats, each contributing uniquely to the development of low-carbon energy systems. Its role is particularly impactful in addressing local concerns and ensuring procedural justice, but it must align with other participatory methods to achieve comprehensive energy transition goals [252]. Therefore, new regional participation formats must be tested that connect top-down and bottom-up approaches as well as collaborative and co-creative formats (see [66, p. 13]).

It continues to be valuable to approach the research and evaluation of energy transitions through the lens of participation, as emphasized in social science perspectives (e.g., 'thinking through participation in renewable energy decisions'; [73]). International literature highlights that while public participation is widely recognized as crucial for the legitimacy and success of energy transitions, its effectiveness largely depends on the local context, the design of participatory processes, and the extent to which these processes are genuinely inclusive and empowering. However, the many deficits of public participation identified in this review must be more closely linked to the real-world conditions of energy transitions on the ground. Therefore, it remains an ongoing task to provide good conditions in every single case of energy transitions. Given the huge challenges of climate change on the one hand, and the political crises facing global democracies with the rise of populism, polarized communication, and post-truth politics on the other, the author stresses the need to create and experiment with new laboratories of participation in energy transitions.

Funding sources

This research was supported by funding from the Energy Research Programme of the Federal Ministry for Economic Affairs and Climate Action of Germany based on the political goals of the German government.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

I thank Marius Albiez, Pia Laborgne and Isabelle Stadelmann-Steffen for their initial involvement in and support of the creation of this paper. Without their help, this project would not have been realized. The same is true for Lisa-Marie Kähler, Viola Stenzhorn, and Zoé Werner, whose

immense help made it possible for this paper to see the light of day. I would also like to thank Andrew Ferron for his support in editing the paper and putting the finishing touches on the finalized version.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.rser.2025.115693.

Data availability

The data that has been used is confidential.

References

[1] Bailey I, Darkal H. (Not) talking about justice: justice self-recognition and the integration of energy and environmental-social justice into renewable energy siting. Local Environ 2018;23(3):335–51. https://doi.org/10.1080/13549839.2017.1418848.

[2] Elmallah S, Rand J. "After the leases are signed, it's a done deal": exploring procedural injustices for utility-scale wind energy planning in the United States. Energy Res Social Sci 2022;89:102549. https://doi.org/10.1016/j.erss.2022.102549.

[3] Scherhaufer P. The complex relations between justice and participation in collaborative planning processes for a renewable energy transition. In: Feldpausch-Parker AM, Endres D, Peterson TR, Gomez SL, editors. Routledge handbook of energy democracy. London: Routledge; 2021. p. 256–69.

[4] Dermont C, Ingold K, Kammermann L, Stadelmann-Steffen I. Bringing the policy making perspective in: a political science approach to social acceptance. Energy Policy 2017;108:359–68. https://doi.org/10.1016/j.enpol.2017.05.062.

[5] Devine-Wright P. Beyond NIMBYism: towards an integrated framework for understanding public perceptions of wind energy. Wind Energy 2005;8(2):125–39. https://doi.org/10.1002/we.124.

[6] Stadelmann-Steffen I, Dermont C. Acceptance through inclusion? Political and economic participation and the acceptance of local renewable energy projects in Switzerland. Energy Res Social Sci 2021;71:101818. https://doi.org/10.1016/j.erss.2020.101818.

[7] Walter G. Determining the local acceptance of wind energy projects in Switzerland: the importance of general attitudes and project characteristics. Energy Res Social Sci 2014;4:78–88. https://doi.org/10.1016/j.erss.2014.09.003.

[8] Rowe G, Frewer LJ. A typology of public engagement mechanisms. Sci Technol Hum Val 2005;30(2):251–90. https://doi.org/10.1177/0162243904271724.

[9] Aitken M. Why we still don't understand the social aspects of wind power: a critique of key assumptions within the literature. Energy Policy 2010;38(4):1834–41. https://doi.org/10.1016/j.enpol.2009.11.060.

[10] Firestone J, Hirt C, Bidwell D, Gardner M, Dwyer J. Faring well in offshore wind power siting? Trust, engagement and process fairness in the United States. Energy Res Social Sci 2020;62:101393. https://doi.org/10.1016/j.erss.2019.101393.

[11] Radtke J. Understanding the Complexity of Governing Energy Transitions: Introducing an Integrated Approach of Policy and Transition Perspectives. Env Pol Gov 2025:eet.2158. https://doi.org/10.1002/eet.2158.

[12] Bryson JM, Quick KS, Slotterback CS, Crosby BC. Designing public participation processes. Public Adm Rev 2013;73(1):23–34. https://doi.org/10.1111/j.1540-6210.2012.02678.x.

[13] Kweit MG, Kweit RW. The politics of policy analysis: the role of citizen participation in analytic decisionmaking. Rev Pol Res 1984;3(2):234–45. https://doi.org/10.1111/j.1541-1338.1984.tb00117.x.

[14] Michels A. Citizen participation in local policy making: design and democracy. Int J Publ Adm 2012;35(4):285–92. https://doi.org/10.1080/01900692.2012.661301.

[15] Quick KS, Bryson JM. Public participation. In: Ansell C, Torfing J, editors. Handbook on theories of governance. Cheltenham, Northampton: Edward Elgar Publishing; 2022. p. 158–68.

[16] Walker GB. Public participation as participatory communication in environmental policy decision-making: from concepts to structured conversations. Envrion Commun 2007;1(1):99–110. https://doi.org/10.1080/17524030701334342.

[17] Geels FW. The multi-level perspective on sustainability transitions: responses to seven criticisms. Environ Innov Soc Transit 2011;1(1):24–40. https://doi.org/10.1016/j.eist.2011.02.002.

[18] Mouter N, Shortall RM, Spruit SL, Itten AV. Including young people, cutting time and producing useful outcomes: participatory value evaluation as a new practice of public participation in the Dutch energy transition. Energy Res Social Sci 2021;75:101965. https://doi.org/10.1016/j.erss.2021.101965.

[19] Newell PJ, Geels FW, Sovacool BK. Navigating tensions between rapid and just low-carbon transitions. Environ Res Lett 2022;17(4):41006. https://doi.org/10.1088/1748-9326/ac622a.

[20] Upham P, Sovacool B, Ghosh B. Just transitions for industrial decarbonisation: a framework for innovation, participation, and justice. Renew Sustain Energy Rev 2022;167:112699. https://doi.org/10.1016/j.rser.2022.112699.

[21] Abas A, Arifin K, Ali MAM, Khairil M. A systematic literature review on public participation in decision-making for local authority planning: a decade of progress and challenges. Environ Dev 2023;46:100853. https://doi.org/10.1016/j.envdev.2023.100853.

[22] Amado M, Vitorino C, Moura E, Silva V. Public participation in sustainable urban planning. Int J Humanity Soc Sci 2010;4:102–8.

[23] Damer S, Hague C. Public participation in planning: a review. Town Plan Rev 1971;42(3):217. https://doi.org/10.3828/tpr.42.3.b274nj807658j756.

[24] Innes JE, Booher DE. Reframing public participation: strategies for the 21st century. Plann Theor Pract 2004;5(4):419–36. https://doi.org/10.1080/1464935042000293170.

[25] Biegelbauer P, Hansen J. Democratic theory and citizen participation: democracy models in the evaluation of public participation in science and technology. Sci Publ Pol 2011;38(8):589–97. https://doi.org/10.3152/030234211X13092649606404.

[26] Chilvers J. Expertise, professionalization, and reflexivity in mediating public participation: perspectives from STS and British science and democracy. In: Bherer L, Gauthier M, Simard L, editors. The professionalization of public participation. New York, London: Routledge; 2017. p. 115–38.

[27] Chilvers J, Longhurst N. Participation in transition(s): reconceiving public engagements in energy transitions as co-produced, emergent and diverse. J Environ Pol Plann 2016;18(5):585–607. https://doi.org/10.1080/1523908X.2015.1110483.

[28] Einsiedel EF. Public participation in science and technology: dialogue, disputations and collaborations. In: Bucchi M, Trench B, editors. Routledge handbook of public communication of science and technology. London, New York: Routledge; 2021. p. 267–90.

[29] Felt U, Fochler M. The bottom-up meanings of the concept of public participation in science and technology. Sci Publ Pol 2008;35(7):489–99. https://doi.org/10.3152/030234208X329086.

[30] Pallett H, Chilvers J. STS and democracy co-produced? The making of public dialogue as a technology of participation. In: Birkbak A, editor. Democratic situations. Manchester: Mattering Press; 2022. p. 118–40.

[31] Strasser BJ, Baudry J, Mahr D, Sanchez G, Tancoigne E. "Citizen science"? Rethinking science and public participation. S&TS 2019:52–76. https://doi.org/10.23987/sts.60425.

[32] Levenda AM, Behrsin I, Disano F. Renewable energy for whom? A global systematic review of the environmental justice implications of renewable energy technologies. Energy Res Social Sci 2021;71:101837. https://doi.org/10.1016/j.erss.2020.101837.

[33] Jenkins K, McCauley D, Heffron R, Stephan H, Rehner R. Energy justice: a conceptual review. Energy Res Social Sci 2016;11:174–82. https://doi.org/10.1016/j.erss.2015.10.004.

[34] van der Wel K, Akerboom S, Meijer A. A public values perspective on energy justice: building a theoretical lens for understanding decision-making in the energy transition. Energy Res Social Sci 2024;116:103677. https://doi.org/10.1016/j.erss.2024.103677.

[35] Sovacool BK, Dworkin MH. Energy justice: conceptual insights and practical applications. Appl Energy 2015;142:435–44. https://doi.org/10.1016/j.apenergy.2015.01.002.

[36] York A, Yazar M. Leveraging shadow networks for procedural justice. Curr Opin Environ Sustain 2022;57:101190. https://doi.org/10.1016/j.cosust.2022.101190.

[37] Webler T, Tuler S. Unlocking the puzzle of public participation. Bull Sci Technol Soc 2002;22(3):179–89. https://doi.org/10.1177/027676020220030002.

[38] Webler T, Tuler S. Unpacking the idea of democratic community consent-based siting for energy infrastructure. J Risk Res 2021;24(1):94–109. https://doi.org/10.1080/13669877.2020.1843068.

[39] Radtke J, Löw Beer D. Legitimizing sustainability transitions through stakeholder participation: evaluating the coal commission in Germany. Energy Res Social Sci 2024;116:103667. https://doi.org/10.1016/j.erss.2024.103667.

[40] Firestone J, Hoen B, Rand J, Elliott D, Hübner G, Pohl J. Reconsidering barriers to wind power projects: community engagement, developer transparency and place. J Environ Pol Plann 2018;20(3):370–86. https://doi.org/10.1080/1523908X.2017.1418656.

[41] Gross C. Community perspectives of wind energy in Australia: the application of a justice and community fairness framework to increase social acceptance. Energy Policy 2007;35(5):2727–36. https://doi.org/10.1016/j.enpol.2006.12.013.

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

[43] Liebe U, Bartczak A, Meyerhoff J. A turbine is not only a turbine: the role of social context and fairness characteristics for the local acceptance of wind power. Energy Policy 2017;107:300–8. https://doi.org/10.1016/j.enpol.2017.04.043.

[44] Liebe U, Dobers GM. Decomposing public support for energy policy: what drives acceptance of and intentions to protest against renewable energy expansion in Germany? Energy Res Social Sci 2019;47:247–60. https://doi.org/10.1016/j.erss.2018.09.004.

[45] Walker BJ, Russel D, Kurz T. Community benefits or community bribes? An experimental analysis of strategies for managing community perceptions of bribery surrounding the siting of renewable energy projects. Environ Behav 2017;49(1):59–83. https://doi.org/10.1177/0013916515605562.

[46] Zoellner J, Schweizer-Ries P, Wemheuer C. Public acceptance of renewable energies: results from case studies in Germany. Energy Policy 2008;36(11):4136–41. https://doi.org/10.1016/j.enpol.2008.06.026.

[47] Ryder S, Walker C, Batel S, Devine-Wright H, Devine-Wright P, Sherry-Brennan F. Do the ends justify the means? Problematizing social acceptance and instrumentally-driven community engagement in proposed energy projects. Socio Ecol Pract Res 2023;5(2):189–204. https://doi.org/10.1007/s42532-023-00148-8.

[48] Skinner-Thompson J. Procedural environmental justice. Wash Law Rev 2022;97 (2):399.

[49] Natarajan L. Socio-spatial learning: a case study of community knowledge in participatory spatial planning. Prog Plann 2017;111:1–23. https://doi.org/10.1016/j.progress.2015.06.002.

[50] Devine-Wright P. Rethinking NIMBYism: the role of place attachment and place identity in explaining place-protective action. Commun Appl Soc Psy 2009;19(6): 426–41. https://doi.org/10.1002/casp.1004.

[51] van Uffelen N, Taebi B, Pesch U. Revisiting the energy justice framework: doing justice to normative uncertainties. Renew Sustain Energy Rev 2024;189:113974. https://doi.org/10.1016/j.rser.2023.113974.

[52] Fung A. Varieties of participation in complex governance. Source: Public Adm Rev 2006;66:66–75.

[53] Bobbio L. Designing effective public participation. Pol Soc 2019;38(1):41–57. https://doi.org/10.1080/14494035.2018.1511193.

[54] Beauchampet I, Walsh B. Energy citizenship in the Netherlands: the complexities of public engagement in a large-scale energy transition. Energy Res Social Sci 2021;76:102056. https://doi.org/10.1016/j.erss.2021.102056.

[55] Di Gregorio M, Fatorelli L, Paavola J, Locatelli B, Pramova E, Nurrochmat DR, et al. Multi-level governance and power in climate change policy networks. Glob Environ Change 2019;54:64–77. https://doi.org/10.1016/j.gloenvcha.2018.10.003.

[56] Fraune C, Knodt M. Challenges of citizen participation in infrastructure policy-making in multi-level systems—the case of onshore wind energy expansion in Germany. Eur Pol Soc Anal 2017;3(2):256–73. https://doi.org/10.1002/epa2.1022.

[57] Kern K, Bulkeley H. Cities, europeanization and multi-level governance: governing climate change through transnational municipal networks. J Common Mark Stud 2009;47(2):309–32. https://doi.org/10.1111/j.1468-5965.2009.00806.x.

[58] Melica G, Bertoldi P, Kona A, Iancu A, Rivas S, Zancanella P. Multilevel governance of sustainable energy policies: the role of regions and provinces to support the participation of small local authorities in the covenant of mayors. Sustain Cities Soc 2018;39:729–39. https://doi.org/10.1016/j.scs.2018.01.013.

[59] Newig J, Fritsch O. Environmental governance: participatory, multi-level – and effective? Env Pol Gov 2009;19(3):197–214. https://doi.org/10.1002/eet.509.

[60] Michels A, Graaf L de. Examining citizen participation: local participatory policymaking and democracy revisited. Local Gov Stud 2017;43(6):875–81. https://doi.org/10.1080/03003930.2017.1365712.

[61] Hermans FLP, Haarmann WMF, Dagevos JFLMM. Evaluation of stakeholder participation in monitoring regional sustainable development. Reg Environ Change 2011;11(4):805–15. https://doi.org/10.1007/s10113-011-0216-y.

[62] Pantić M, Cilliers J, Cimadomo G, Montaño F, Olufemi O, Torres Mallma S, et al. Challenges and opportunities for public participation in urban and regional planning during the COVID-19 pandemic—lessons learned for the future. Land 2021;10(12):1379. https://doi.org/10.3390/land10121379.

[63] Wilke M. Public participation in marine spatial planning in Iceland. Front Mar Sci 2023;10. https://doi.org/10.3389/fmars.2023.1154645.

[64] Mäkinen K. Scales of participation and multi-scalar citizenship in EU participatory governance. Environ Plan C Politics Space 2021;39(5):1011–29. https://doi.org/10.1177/2399654420981379.

[65] Kamlage J-H, Nanz P. Crisis and participation in the European Union: Energy policy as a test bed for a new politics of citizen participation. Glob Soc 2017;31 (1):65–82. https://doi.org/10.1080/13600826.2016.1235553.

[66] Radtke J, Renn O. Participation in energy transitions: a comparison of policy styles. Energy Res Social Sci 2024;118:103743. https://doi.org/10.1016/j.erss.2024.103743.

[67] Dahl RA. A democratic dilemma: system effectiveness versus citizen participation. Polit Sci Q 1994;109(1):23–34. https://doi.org/10.2307/2151659.

[68] van Deth JW, Ramón Montero J, Westholm A. Citizenship and involvement in European democracies. Routledge; 2007.

[69] Jones DC, Kalmi P. Economies of Scale Versus Participation: a Co-operative Dilemma? JEOD 2012;1:37–64. https://doi.org/10.5947/jeod.2012.003.

[70] Ott D. Small is democratic. Milton Park. Routledge; 2018.

[71] Bell D, Gray T, Haggett C, Swaffield J. Re-visiting the 'social gap': public opinion and relations of power in the local politics of wind energy. Environ Polit 2013;22 (1):115–35. https://doi.org/10.1080/09644016.2013.755793.

[72] Stadelmann-Steffen I, Vatter A. Does satisfaction with democracy really increase happiness? Direct democracy and individual satisfaction in Switzerland. Polit Behav 2012;34(3):535–59. https://doi.org/10.1007/s11109-011-9164-y.

[73] Bidwell D. Thinking through participation in renewable energy decisions. Nat Energy 2016;1(5). https://doi.org/10.1038/nenergy.2016.51.

[74] van der Horst D. NIMBY or not? Exploring the relevance of location and the politics of voiced opinions in renewable energy siting controversies. Energy Policy 2007;35(5):2705–14. https://doi.org/10.1016/j.enpol.2006.12.012.

[75] Mills SB, Bessette D, Smith H. Exploring landowners' post-construction changes in perceptions of wind energy in Michigan. Land Use Policy 2019;82:754–62. https://doi.org/10.1016/j.landusepol.2019.01.010.

[76] Lennon B, Dunphy NP, Sanvicente E. Community acceptability and the energy transition: a citizens' perspective. Energ Sustain Soc 2019;9(1). https://doi.org/10.1186/s13705-019-0218-z.

[77] van Veelen B. Negotiating energy democracy in practice: governance processes in community energy projects. Environ Polit 2018;27(4):644–65. https://doi.org/10.1080/09644016.2018.1427824.

[78] Hoen B, Firestone J, Rand J, Elliot D, Hübner G, Pohl J, et al. Attitudes of U.S. wind turbine neighbors: analysis of a nationwide survey. Energy Policy 2019;134: 110981. https://doi.org/10.1016/j.enpol.2019.110981.

[79] Wolsink M. Wind power and the NIMBY-myth: institutional capacity and the limited significance of public support. Renew Energy 2000;21(1):49–64. https://doi.org/10.1016/S0960-1481(99)00130-5.

[80] Dwyer J, Bidwell D. Chains of trust: energy justice, public engagement, and the first offshore wind farm in the United States. Energy Res Social Sci 2019;47: 166–76. https://doi.org/10.1016/j.erss.2018.08.019.

[81] Aas Ø, Devine-Wright P, Tangeland T, Batel S, Ruud A. Public beliefs about high-voltage powerlines in Norway, Sweden and the United Kingdom: a comparative survey. Energy Res Social Sci 2014;2:30–7. https://doi.org/10.1016/j.erss.2014.04.012.

[82] Suškevičs M, Eiter S, Martinat S, Stober D, Vollmer E, Boer CL de, et al. Regional variation in public acceptance of wind energy development in Europe: what are the roles of planning procedures and participation? Land Use Policy 2019;81: 311–23. https://doi.org/10.1016/j.landusepol.2018.10.032.

[83] Osae IB, Mardiste P, Stober D, Eiter S, Buchecker M, Suškevičs M. Access to information and public participation: evaluating the implementation of the aarhus convention in Europe. Eur Plan Stud 2024;32(12):2449–72. https://doi.org/10.1080/09654313.2024.2371508.

[84] Renn O, Webler T, Wiedemann P. Fairness and competence in citizen participation. Dordrecht: Springer Netherlands; 1995.

[85] Jenkins KEH, Sovacool BK, Mouter N, Hacking N, Burns M-K, McCauley D. The methodologies, geographies, and technologies of energy justice: a systematic and comprehensive review. Environ Res Lett 2021;16(4):43009. https://doi.org/10.1088/1748-9326/abd78c.

[86] Conrad E, Cassar L F, Jones M, Eiter S, Izaovičová Z, Barankova Z, et al. Rhetoric and reporting of public participation in landscape policy. J Environ Pol Plann 2011;13(1):23–47. https://doi.org/10.1080/1523908X.2011.560449.

[87] Bandelow NC, Sager F, Biegelbauer P. Policy analysis in the German-speaking countries: common traditions, different cultures, in Germany, Austria and Switzerland. In: Blum S, Schubert K, editors. Policy analysis in Germany. Bristol: Policy Press; 2013. p. 75–90.

[88] Berisha E, Cotella G, Janin Rivolin U, Solly A. Spatial governance and planning systems in the public control of spatial development: a European typology. Eur Plan Stud 2021;29(1):181–200. https://doi.org/10.1080/09654313.2020.1726295.

[89] Seidl R, Wirth T von, Krütli P. Social acceptance of distributed energy systems in Swiss, German, and Austrian energy transitions. Energy Res Social Sci 2019;54: 117–28. https://doi.org/10.1016/j.erss.2019.04.006.

[90] Woerter M, Stucki T, Arvanitis S, Rammer C, Peneder M. The adoption of green energy technologies: the role of policies in Austria, Germany, and Switzerland. Int J Green Energy 2017;14(14):1192–208. https://doi.org/10.1080/15435075.2017.1381612.

[91] Bazeley P. Qualitative data analysis: practical strategies. Los Angeles, London, New Delhi, Singapore, Washington DC, Melbourne: SAGE Publications Ltd; 2020.

[92] Neuendorf KA. The content analysis guidebook. Los Angeles, London, New Delhi, Singapore, Washington DC, Melbourne: SAGE Publications, Inc; 2016.

[93] Creswell JW, Poth CN. Qualitative inquiry and research design: choosing among five approaches. fourth ed. Los Angeles: SAGE Publications, Inc; 2017.

[94] Ravitch SM, Carl NM. Qualitative research: bridging the conceptual, theoretical, and methodological. second ed. Los Angeles: SAGE Publications, Inc; 2020.

[95] Aurini J, Heath M, Howells S. The how To of qualitative research. second ed. SAGE Publications Ltd; 2021.

[96] Mayring P. Qualitative content analysis: a step-by-step guide. Los Angeles, London, New Delhi, Singapore, Washington DC, Melbourne: SAGE Publications Ltd; 2022.

[97] Kuckartz U, Rädiker S. Qualitative content analysis: methods, practice and software. Thousand Oaks: SAGE Publications Ltd; 2023.

[98] Miles MB, am Huberman, Saldaña J. Qualitative data analysis: a methods sourcebook. fourth ed. Los Angeles: SAGE Publications, Inc; 2019.

[99] Urquhart C. Grounded theory for qualitative research: a practical guide. Los Angeles, London, New Delhi, Singapore, Washington DC, Melbourne: SAGE Publications Ltd; 2022.

[100] Adu P. A step-by-step guide to qualitative data coding. London: Routledge; 2019.

[101] Auerbach C, Silverstein LB. Qualitative data: an introduction to coding and analysis. NYU Press; 2003.

[102] St Pierre EA, Jackson AY. Qualitative data analysis after coding. Qual Inq 2014;20 (6):715–9. https://doi.org/10.1177/1077800414532435.

[103] Elliott V. Thinking about the coding process in qualitative data analysis. Qual Rep 2018;23. https://doi.org/10.46743/2160-3715/2018.3560.

[104] Saldaña J. The coding manual for qualitative researchers. Los Angeles, London, New Delhi, Singapore, Washington DC, Melbourne: SAGE Publications Ltd; 2021.

[105] Swanson RA, Holton EF. Research in organizations: foundations and methods in inquiry. San Francisco: Berrett-Koehler Publishers; 2005.

[106] Ernst A, Shamon H. Public participation in the German energy transformation: examining empirically relevant factors of participation decisions. Energy Policy 2020;145:111680. https://doi.org/10.1016/j.enpol.2020.111680.

[107] Langer K. Frühzeitige Planungskommunikation – ein Schlüssel zur Konfliktbewältigung bei der Energiewende? In: Kühne O, Weber F, editors. Bausteine der Energiewende. Wiesbaden: Springer Fachmedien Wiesbaden; 2018. p. 539–56.

[108] Leibenath M, Wirth P, Lintz G. Just a talking shop? – informal participatory spatial planning for implementing state wind energy targets in Germany. Util Policy 2016;41:206–13. https://doi.org/10.1016/j.jup.2016.02.008.
[109] Stracke M. Öffentlichkeitsbeteiligung im Übertragungsnetzausbau: akzeptanzförderung als neues gesetzgeberisches Leitbild: Umsetzung und Defizite unter Berücksichtigung der TEN-E-Verordnung Nr. 347/2013. 2017. Baden-Baden: Nomos.
[110] Ziekow J, Ewen C, Barth R, Schütte S. Neuartiger Öffentlichkeitsdialog in Verfahren mit Umweltprüfung am Beispiel bestimmter Vorhabentypen/ Vorhabeneigenschaften — Leitfäden für Behörden und rechtliche Verankerung. Speyer: Deutsches Forschungsinstitut für Öffentliche Verwaltung 2014. https://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_07_2015_neuartiger_oeffentlichkeitsdialog.pdf.
[111] Local Energy Consulting. Akzeptanz und lokale Teilhabe in der Energiewende. Handlungsempfehlungen für eine umfassende Akzeptanzpolitik. 2020 https://www.agora-energiewende.de/fileadmin/Projekte/2020/2020_07_EE-Akzeptanz/182_A-EW_Akzeptanz-Energiewende_WEB.pdf.
[112] Ewen C, Knapstein Y. Das Beste beider Welten: gute Übergänge von der frühzeitigen in die förmliche Öffentlichkeitsbeteiligung für. Infrastrukturvorhaben 2021. https://cdn.prod.website-files.com/65b410bd93410b3e33d59c3b/65b410bd93410b3e33d5a25c_uvp-report35_2e.pdf.
[113] Dunker R, Mono R. Bürgerbeteiligung und erneuerbare Energien. Kurz-Studie von Beteiligungsprojekten in Deutschland durch die 100 prozent erneuerbar stiftung. 2013 https://100-prozent-erneuerbar.de/wp-content/uploads/2013_Kurzstudie_Buergerbeteiligung_und_Erneuerbare_Energien.pdf.
[114] Komendantova N, Battaglini A. Beyond decide-announce-defend (DAD) and not-in-my-backyard (NIMBY) models? Addressing the social and public acceptance of electric transmission lines in Germany. Energy Res Social Sci 2016;22:224–31. https://doi.org/10.1016/j.erss.2016.10.001.
[115] Stober D, Suškevičs M, Eiter S, Müller S, Martinát S, Buchecker M. What is the quality of participatory renewable energy planning in Europe? A comparative analysis of innovative practices in 25 projects. Energy Res Social Sci 2021;71:101804. https://doi.org/10.1016/j.erss.2020.101804.
[116] Fraune C, Knodt M. Politische Partizipation in der Mehrebenengovernance der Energiewende als institutionelles Beteiligungsparadox. In: Fraune C, Knodt M, Gölz S, Langer K, editors. Akzeptanz und politische Partizipation in der Energietransformation. Wiesbaden: Springer Fachmedien Wiesbaden; 2019. p. 159–82.
[117] Grünwald R, Ahmels P, Banthien H, Bimesdörfer K, Grünert J, Revermann, et al. Handlungsmöglichkeiten für Kommunikation und Beteiligung beim Stromnetzausbau, vol. 20. TAB Hintergrundpapier; 2015. https://www.tab-beim-bundestag.de/de/pdf/publikationen/berichte/TAB-Hintergrundpapier-hp020.pdf.
[118] Hellmuth N, Jakobs E-M. Konfliktkommunikation für Energieinfrastrukturprojekte. Z Energiewirtschaft 2021;45(2):133–51. https://doi.org/10.1007/s12398-021-00301-4.
[119] Holtkamp L. Grenzen der Bürgerbeteiligung vor Ort. Akteursinteressen und Praxisprobleme am Beispiel von Bürgerhaushalten und Standortkonflikten. In: Lorenz A, Hoffmann CP, Hitschfeld U, editors. Partizipation für alle und alles? Wiesbaden: Springer Fachmedien Wiesbaden; 2020. p. 241–61.
[120] Rau I, Schweizer-Ries P, Hildebrand J. Participation. The silver bullet for the acceptance of renewable energies? In: Kabisch S, Kunath A, Schweizer-Ries P, Steinführer A, editors. Vulnerability, risks, and complexity. Impacts of global change on human habitats. Cambridge, Göttingen: Hogrefe Publishing; 2012. p. 177–92.
[121] Rau I, Zoellner J. Projektabschlussbericht „Aktivität und Teilhabe – akzeptanz Erneuerbarer Energien durch Beteiligung steigern. https://www.fachagentur-windenergie.de/fileadmin/files/Akzeptanz/209_0_Abschlussbericht_Aktivitaet_Teilhabe_FKZ_0325052_oeffentlich.pdf; 2011.
[122] Borg A, Bauer MJ. TIGER – kommunikationskonzept tiefe geothermie. Wiesbaden: Springer Fachmedien Wiesbaden; 2017.
[123] Voigt F. Konfliktmoderation und Mediation mit Gegenwind - bürgerforum Energiewende Hessen. Hessische Blätter für Volksbildung 2021;71:62–6. https://doi.org/10.3278/HBV2103W007.
[124] Richter I. Bürgerbeteiligung in der Energiewende - Grundlagen für eine systematische Erfassung der Beteiligungspraxis: Abschlussbericht zu Modul B (Bestandsaufnahme) des Forschungsprojektes DEMOENERGIE - die Transformation des Energiesystems als Treiber demokratischer Innovationen. https://www.ssoar.info/ssoar/bitstream/handle/document/47310/ssoar-2016-richter-Burgerbeteiligung_in_der_Energiewende_Grundlagen.pdf?sequence=1&isAllowed=y&lnkname=ssoar-2016-richter-Burgerbeteiligung_in_der_Energiewende_Grundlagen.pdf; 2016.
[125] Roßnagel A, Birzle-Harder B, Ewen C, Götz K, Hentschel A, Horelt M-A, et al. Entscheidungen über dezentrale Energieanlagen in der Zivilgesellschaft: vorschläge zur Verbesserung der Planungs- und Genehmigungsverfahren, Interdisciplinary research on climate change mitigation and adaption. Kassel: Kassel University Press; 2016.
[126] Radtke J, Renn O. Partizipation und bürgerschaftliches Engagement in der Energiewende. In: Radtke J, Canzler W, editors. Energiewende: eine sozialwissenschaftliche Einführung. Wiesbaden: Springer Fachmedien Wiesbaden; 2019. p. 283–316.
[127] Mostegl NM, Pröbstl-Haider U, Haider W. Spatial energy planning in Germany: between high ambitions and communal hesitations. Landsc Urban Plann 2017;167:451–62. https://doi.org/10.1016/j.landurbplan.2017.07.013.
[128] Hitzeroth M, Megerle A. Renewable energy projects: acceptance risks and their management. Renew Sustain Energy Rev 2013;27:576–84. https://doi.org/10.1016/j.rser.2013.07.022.
[129] Richter I, Danelzik M, Molinengo G, Nanz P, Rost D. Bürgerbeteiligung in der Energiewende. Zehn Thesen zur gegenwärtigen Etablierung, zu Herausforderungen und geeigneten Gestaltungsansätzen. Potsdam: IASS Working Paper; 2016.
[130] Schroeter R, Zirke D. The contact group—public participation in the distribution network expansion in Baden-Württemberg. In: Renn O, Ulmer F, Deckert A, editors. The role of public participation in energy transitions. London, San Diego, Cambridge, Oxford: Academic Press; 2020. p. 191–200.
[131] Bauer C. Stiftung von Legitimation oder Partizipationsverflechtungsfalle. Welche Folgen hat die Öffentlichkeitsbeteiligung beimStromnetzausbau? dms 2015;8(2):273–93. https://doi.org/10.3224/dms.v8i1.21191.
[132] Hellmuth N, Jakobs E-M. Partizipationsformate für Stromnetzausbauprojekte im ruralen Raum. In: Fraune C, Knodt M, Gölz S, Langer K, editors. Akzeptanz und politische Partizipation in der Energietransformation. Wiesbaden: Springer Fachmedien Wiesbaden; 2019. p. 183–207.
[133] Neukirch M. Grinding the grid: contextualizing protest networks against energy transmission projects in Southern Germany. Energy Res Social Sci 2020;69:101585. https://doi.org/10.1016/j.erss.2020.101585.
[134] Renn O. Partizipation bei öffentlichen Planungen. Möglichkeiten, Grenzen, Reformbedarf. In: Keil SI, Thaidigsmann SI, editors. Zivile Bürgergesellschaft und Demokratie. Wiesbaden: Springer Fachmedien Wiesbaden; 2013. p. 71–96.
[135] Weber F. Konflikte um die Energiewende. Wiesbaden: Springer Fachmedien Wiesbaden; 2018.
[136] Koch S, Odparlik L, Köppel J. Wo steht die Partizipation beim -Netzausbau? Naturschutz Landschaftsplan 2014;46(4):116–23.
[137] Hildebrand J, Rau I, Schweizer-Ries P. Die Bedeutung dezentraler Beteiligungprozesse für die Akzeptanz des Ausbaus erneuerbarer Energien. Eine umweltpsychologische Betrachtung. Inf Raumentwickl 2012;9:491–502.
[138] Alcántara S, Kuhn R, Renn O, Bach N, Böhm B, Dienel H-L, et al. DELIKAT – fachdialoge Deliberative Demokratie: analyse partizipativer Verfahren für den Transformationsprozess. Dessau-Roßlau: Umweltbundesamt; 2014. https://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_31_2014_delikat-fachdialoge_deliberative_demokratie.pdf.
[139] Fink S, Ruffing E. Öffentlichkeitsbeteiligung durch private Akteure: eine empirische Analyse des deutschen Verfahrens zur Erstellung von Netzentwicklungsplänen. In: Radtke J, Kersting N, editors. Energiewende: politikwissenschaftliche perspektiven. Wiesbaden: Springer Fachmedien Wiesbaden; 2018. p. 245–67.
[140] Hübner G. Citizen participation for wind energy: experiences from Germany and beyond. In: Renn O, Ulmer F, Deckert A, editors. The role of public participation in energy transitions. London, San Diego, Cambridge, Oxford: Academic Press; 2020. p. 179–90.
[141] Lienhoop N. Acceptance of wind energy and the role of financial and procedural participation: an investigation with focus groups and choice experiments. Energy Policy 2018;118:97–105. https://doi.org/10.1016/j.enpol.2018.03.063.
[142] Schnelle K, Voigt M. Energiewende und Bürgerbeteiligung: Öffentliche Akzeptanz von Infrastruktur-Projekten am Beispiel der. Thüringer strombrücke. Erfurt: Heinrich-Böll-Stiftung Thüringen; 2012. http://www.boell-thueringen.de/sites/default/files/energiewende_und_burgerbeteiligung.pdf.
[143] Steinbach A. Barriers and solutions for expansion of electricity grids—the German experience. Energy Policy 2013;63:224–9. https://doi.org/10.1016/j.enpol.2013.08.073.
[144] Dvarioniene J, Gurauskiene I, Gecevicius G, Trummer DR, Selada C, Marques I, et al. Stakeholders involvement for energy conscious communities: the energy labs experience in 10 European communities. Renew Energy 2015;75:512–8. https://doi.org/10.1016/j.renene.2014.10.017.
[145] Fink S, Ruffing E. Learning in iterated consultation procedures – the example of the German electricity grid demand planning. Util Policy 2020;65:101065. https://doi.org/10.1016/j.jup.2020.101065.
[146] Fink S, Ruffing E, Burst T, Chinnow SK. Less complex language, more participation: how consultation documents shape participatory patterns. Int Groups Adv 2021;10(3):199–220. https://doi.org/10.1057/s41309-021-00123-2.
[147] Kubicek H. Mitreden beim Netzausbau. Erwartungen, Wissenstand und Empfehlungen. In: Wissenschaftsdialog, editor. Bundesnetzagentur. Bonn: Bundesnetzagentur; 2013. p. 1–23.
[148] Roßnagel A, Ewen C, Götz K, Hefter T, Hentschel A, Huge A. Mit Interessengegensätzen fair umgehen – zum Einbezug der Öffentlichkeit in Entscheidungsprozesse zu dezentralen Energieanlagen. Zeitschrift für Neues Energierecht 2014;4:329–37.
[149] Huge A. Die Öffentlichkeitsbeteiligung in Planungs- und Genehmigungsverfahren dezentraler Energieanlagen, Interdisciplinary Research on Climate Change Mitigation and Adaption. Kassel: Kassel University Press GmbH; 2018.
[150] Langer K. Landschaft und Partizipation: landschaft fokussiert zur Sprache bringen – effektives Verfahrensdesign. In: Kühne O, Weber F, Berr K, Jenal C, editors. Handbuch landschaft. Wiesbaden: Springer Fachmedien Wiesbaden; 2019. p. 535–45.
[151] Langer K, Decker T, Roosen J, Menrad K. A qualitative analysis to understand the acceptance of wind energy in Bavaria. Renew Sustain Energy Rev 2016;64:248–59. https://doi.org/10.1016/j.rser.2016.05.084.
[152] Bock S, Reimann B, Abt J, Lettow M, Vorwerk U. Beteiligungsverfahren bei umweltrelevanten Vorhaben. Berlin: Deutsches Institut für Urbanistik gGmbH; 2017. https://www.umweltbundesamt.de/sites/default/files/medien/1410/

publikationen/2017-05-30_texte_37-2017_beteiligungsverfahren-umweltvorhaben.pdf.
[153] Reusswig F, Braun F, Heger I, Ludewig T, Eichenauer E, Lass W. Against the wind: local opposition to the German energiewende. Util Policy 2016;41:214–27. https://doi.org/10.1016/j.jup.2016.02.006.
[154] Weber F, Jenal C. Gegen den Wind: konfliktlinien beim Ausbau erneuerbarer Energien in Großschutzgebieten am Beispiel der Windenergie in den Naturparken Soonwald-Nahe und Rhein-Westerwald. In: Weber F, Weber F, Jenal C, editors. Wohin des Weges?: regionalentwicklung in Großschutzgebieten. Hannover: Akademie für Raumforschung und Landesplanung; 2018. p. 217–49.
[155] Hage G, Schuster L. Daher weht der Wind! Beleuchtung der Diskussionsprozesse ausgewählter Windkraftplanungen in Baden-Württemberg. In: Kühne O, Weber F, editors. Bausteine der Energiewende. Wiesbaden: Springer Fachmedien Wiesbaden; 2018. p. 681–700.
[156] Weber F, Kühne O, Jenal C, Sanio T, Langer K, Igel M. Analyse des öffentlichen Diskurses zu gesundheitlichen Auswirkungen von Hochspannungsleitungen. Handlungsempfehlungen für die strahlenschutzbezogene Kommunikation beim Stromnetzausbau. Salzgitter: Bundesamt für Strahlenschutz. 2016 http://doris.bfs.de/jspui/bitstream/urn:nbn:de:0221-2016050414038/3/BfS_2016_3614S80008.pdf.
[157] Domasch S., Zschiesche M. Erhebung, Analyse und Bewertung von Maßnahmen der Öffentlichkeitsbeteiligung im Standortauswahlverfahren. Berlin: Bundesamt für kerntechnische Entsorgungssicherheit. 2017. https://www.base.bund.de/SharedDocs/Downloads/BASE/DE/fachinfo/fa/190103_soa_oe-beteiligung-end.pdf.
[158] Zimmer R, Kloke S, Gaedtke M. Der Streit um die Uckermarkleitung - Eine Diskursanalyse. Studie im Rahmen des UfU-Schwerpunktes “Erneuerbare Energien im Konflikt”. UfU-Paper 3/2012. Berlin: Unabhängiges Institut für Umweltfragen e.V. 2012 https://www.ufu.de/wp-content/uploads/2016UfU-Paper_3-2012_Zimmer_Kloke_Gaedtke.pdf.
[159] Bauer C. Entpolitisierung von Zulassungsund Genehmigungsverfahren für Energiewendeprojekte? In: Schomaker R, editor. Die europäische Energiewende. Berlin, Boston: De Gruyter; 2017. p. 127–48.
[160] Barth R, Ewen C, Schütte S, Ziekow J. Konfliktdialog bei der Zulassung von Vorhaben der Energiewende. In: Holstenkamp L, Radtke J, editors. Handbuch Energiewende und Partizipation. Wiesbaden: Springer Fachmedien Wiesbaden; 2018. p. 583–95.
[161] Kapeller S, Biegelbauer P. How (not) to solve local conflicts around alternative energy production: six cases of siting decisions of Austrian wind power parks. Util Policy 2020;65:101062. https://doi.org/10.1016/j.jup.2020.101062.
[162] Mandel K. Warum plant Ihr eigentlich noch? – die Energiewende in der Region Heilbronn-Franken. In: Kühne O, Weber F, editors. Bausteine der Energiewende. Wiesbaden: Springer Fachmedien Wiesbaden; 2018. p. 701–13.
[163] Hanger S, Komendantova N, Schinke B, Zejli D, Ihlal A, Patt A. Community acceptance of large-scale solar energy installations in developing countries: evidence from Morocco. Energy Res Social Sci 2016;14:80–9. https://doi.org/10.1016/j.erss.2016.01.010.
[164] Huge A, Roßnagel A. Möglichkeiten der Öffentlichkeitsbeteiligung in Planungs- und Genehmigungsverfahren von Windenergieanlagen. In: Holstenkamp L, Radtke J, editors. Handbuch Energiewende und Partizipation. Wiesbaden: Springer Fachmedien Wiesbaden; 2018. p. 613–25.
[165] Diduck AP, Pratap D, Sinclair AJ, Deane S. Perceptions of impacts, public participation, and learning in the planning, assessment and mitigation of two hydroelectric projects in Uttarakhand, India. Land Use Policy 2013;33:170–82. https://doi.org/10.1016/j.landusepol.2013.01.001.
[166] Becker S, Bues A, Naumann M, Betancourt C. Die Analyse lokaler energiepolitischer Konflikte und das Entstehen neuer Organisationsformen. Theoretische Zugänge und aktuelle Herausforderungen. Erkner, Freiburg, Potsdam; 2014. EnerLOG Working Paper No. 1, https://www.geo.fu-berlin.de/geog/fachrichtungen/anthrogeog/g-t-g/ehemalige-MitarbeiterInnen/naumann/EnerLOG_wp1_2014.pdf.
[167] Quénéhervé G, Tischler J, Hochschild V. Energiewende im Quartier – ein Ansatz im Reallabor. In: Kühne O, Weber F, editors. Bausteine der Energiewende. Wiesbaden: Springer Fachmedien Wiesbaden; 2018. p. 385–405.
[168] Biegelbauer P, Kapeller S. Mitentscheiden oder Mitgestalten: Direkte Demokratie versus dialogorientierte Verfahren in lokalen Entscheidungsfindungsprozessen. SWS-Rundschau 2017;57:32–55.
[169] Könen D, Gryl I, Pokraka J. Zwischen ‚Windwahn‘, Interessenvertretung und Verantwortung: bürger*innenbeteiligung am Beispiel Windkraft im Spiegel von Neocartography und Spatial Citizenship. In: Kühne O, Weber F, editors. Bausteine der Energiewende. Wiesbaden: Springer Fachmedien Wiesbaden; 2018. p. 207–30.
[170] Wirth P, Leibenath M. Die Rolle der Regionalplanung im Umgang mit Windenergiekonflikten in Deutschland und Perspektiven für die raumbezogene Forschung. RuR 2017;75(4). https://doi.org/10.1007/s13147-016-0436-1.
[171] Liu B, Hu Y, Wang A, Yu Z, Yu J, Wu X. Critical factors of effective public participation in sustainable energy projects. J Manag Eng 2018;34(5). https://doi.org/10.1061/(ASCE)ME.1943-5479.0000635.
[172] Stadelmann-Steffen I, Ingold K, Rieder S, Dermont C, Kammermann L, Strotz C. Akzeptanz erneuerbarer Energie. Bern: Universität Bern. Interface Politikstudien Forschung Beratung; 2018.
[173] Neukirch M. Die Dynamik des Konflikts um den Stromtrassenbau: stabilität, Wandel oder Stagnation? (Working Paper No. 2017– 04). Stuttgarter Beiträge zur Organisations- und Innovationsforschung. SOI Discussion Paper; 2017. http://hdl.handle.net/10419/170579.
[174] Huang P, Castán Broto V, Westman LK. Emerging dynamics of public participation in climate governance: a case study of solar energy application in Shenzhen, China. Env Pol Gov 2020;30(6):306–18. https://doi.org/10.1002/eet.1886.
[175] Hildebrand J, Rau I, Schweizer-Ries P. Höhere öffentliche Akzeptanz durch bessere Beteiligungsverfahren? UVP-Report: informationen zu Umweltverträglichkeitsprüfung. Umweltmanagement und nachhaltiger Entwicklung 2017;31:269–73.
[176] Roßmeier A, Weber F. Stürmische Zeiten: bürgerschaftliches Engagement beim Windkraftausbau zwischen Befürwortung und Ablehung. In: Stefansky A, Göb A, editors. Bitte wenden Sie!" - herausforderungen und Chancen der Energiewende. Hannover: Verl. d. ARL; 2018. p. 52–79.
[177] Jenal C. Ikonologie des Protests – Der Stromnetzausbau im Darstellungsmodus seiner Kritiker(innen). In: Kühne O, Weber F, editors. Bausteine der Energiewende. Wiesbaden: Springer Fachmedien Wiesbaden; 2018. p. 469–87.
[178] Hildebrand J, Renn O. Akzeptanz in der Energiewende. In: Radtke J, Canzler W, editors. Energiewende: eine sozialwissenschaftliche Einführung. Wiesbaden: Springer Fachmedien Wiesbaden; 2019. p. 261–82.
[179] Roddis P, Carver S, Dallimer M, Norman P, Ziv G. The role of community acceptance in planning outcomes for onshore wind and solar farms: an energy justice analysis. Appl Energy 2018;226:353–64. https://doi.org/10.1016/j.apenergy.2018.05.087.
[180] Sovacool BK, Lakshmi Ratan P. Conceptualizing the acceptance of wind and solar electricity. Renew Sustain Energy Rev 2012;16(7):5268–79. https://doi.org/10.1016/j.rser.2012.04.048.
[181] Pellizzone A, Allansdottir A, Franco R de, Muttoni G, Manzella A. Exploring public engagement with geothermal energy in southern Italy: a case study. Energy Policy 2015;85:1–11. https://doi.org/10.1016/j.enpol.2015.05.002.
[182] McLaren Loring J. Wind energy planning in England, Wales and Denmark: factors influencing project success. Energy Policy 2007;35(4):2648–60. https://doi.org/10.1016/j.enpol.2006.10.008.
[183] Spandagos C, Tovar Reaños MA, Lynch MÁ. Public acceptance of sustainable energy innovations in the European Union: a multidimensional comparative framework for national policy. J Clean Prod 2022;340:130721. https://doi.org/10.1016/j.jclepro.2022.130721.
[184] Franzius C. Ansätze eines analytisch-deliberativen Verfahrensmodells für die Stromnetzplanung. Verwaltungsarchiv 2015;106:76–111.
[185] Schweizer P-J, Bovet J. The potential of public participation to facilitate infrastructure decision-making: lessons from the German and European legal planning system for electricity grid expansion. Util Policy 2016;42:64–73. https://doi.org/10.1016/j.jup.2016.06.008.
[186] Gill-Wiehl A, Miles S, Wu J, Kammen DM. Beyond customer acquisition: a comprehensive review of community participation in mini grid projects. Renew Sustain Energy Rev 2022;153:111778. https://doi.org/10.1016/j.rser.2021.111778.
[187] Liu L, Bouman T, Perlaviciute G, Steg L. Public participation in decision making, perceived procedural fairness and public acceptability of renewable energy projects. Energy Clim Change 2020;1:100013. https://doi.org/10.1016/j.egycc.2020.100013.
[188] Peñaloza D, Mata É, Fransson N, Fridén H, Samperio Á, Quijano A, et al. Social and market acceptance of photovoltaic panels and heat pumps in Europe: a literature review and survey. Renew Sustain Energy Rev 2022;155:111867. https://doi.org/10.1016/j.rser.2021.111867.
[189] Sontheim T, Weber F. Erdverkabelung und Partizipation als mögliche Lösungswege zur weiteren Ausgestaltung des Stromnetzausbaus? In: Kühne O, Weber F, editors. Bausteine der Energiewende. Wiesbaden: Springer Fachmedien Wiesbaden; 2018. p. 609–30.
[190] Vuichard P, Stauch A, Wüstenhagen R. Keep it local and low-key: social acceptance of alpine solar power projects. Renew Sustain Energy Rev 2021;138:110516. https://doi.org/10.1016/j.rser.2020.110516.
[191] Langer K, Decker T, Roosen J, Menrad K. Factors influencing citizens’ acceptance and non-acceptance of wind energy in Germany. J Clean Prod 2018;175:133–44. https://doi.org/10.1016/j.jclepro.2017.11.221.
[192] Sütterlin B, Siegrist M. Public acceptance of renewable energy technologies from an abstract versus concrete perspective and the positive imagery of solar power. Energy Policy 2017;106:356–66. https://doi.org/10.1016/j.enpol.2017.03.061.
[193] Bräuer M. Energiewende und Bürgerproteste. Eine Untersuchung der Kommunikation von Bürgerinitiativen im Themenfeld Netzausbau, Nachhaltigkeits-, Energie- und Umweltkommunikation. Ilmenau: Universitätsverlag Ilmenau. 2017.
[194] Lintz G, Leibenath M. The politics of energy landscapes: the influence of local anti-wind initiatives on state policies in Saxony, Germany. Energ Sustain Soc 2020;10(1). https://doi.org/10.1186/s13705-019-0230-3.
[195] Roßmeier A, Weber F, Kühne O. Wandel und gesellschaftliche Resonanz – Diskurse um Landschaft und Partizipation beim Windkraftausbau. In: Kühne O, Weber F, editors. Bausteine der Energiewende. Wiesbaden: Springer Fachmedien Wiesbaden; 2018. p. 653–79.
[196] Schmidt P, Lilliestam J. Reducing or fostering public opposition? A critical reflection on the neutrality of Pan-European cost–benefit analysis in electricity transmission planning. Energy Res Social Sci 2015;10:114–22. https://doi.org/10.1016/j.erss.2015.07.003.
[197] Weber F, Jenal C, Rossmeier A, Kühne O. Conflicts around Germany’s Energiewende Discourse patterns of citizens’ initiatives. Quaest Geogr 2017;36(4):117–30. https://doi.org/10.1515/quageo-2017-0040.
[198] Renn O. Akzeptanz und Energiewende. Bürgerbeteiligung als Voraussetzung für gelingende Transformationsprozesse. Jahrb für Christliche Sozialwiss 2015;56:133–54.

[199] Rohe S, Chlebna C. A spatial perspective on the legitimacy of a technological innovation system: regional differences in onshore wind energy. Energy Policy 2021;151:112193. https://doi.org/10.1016/j.enpol.2021.112193.
[200] Schroeter R, Scheel O, Renn O, Schweizer P-J. Testing the value of public participation in Germany: theory, operationalization and a case study on the evaluation of participation. Energy Res Social Sci 2016;13:116–25. https://doi.org/10.1016/j.erss.2015.12.013.
[201] Weber F. Stromnetzausbau und Landschaft. In: Kühne O, Weber F, Berr K, Jenal C, editors. Handbuch landschaft. Wiesbaden: Springer Fachmedien Wiesbaden; 2019. p. 871–83.
[202] Heras-Saizarbitoria I, Cilleruelo E, Zamanillo I. Public acceptance of renewables and the media: an analysis of the Spanish PV solar experience. Renew Sustain Energy Rev 2011;15(9):4685–96. https://doi.org/10.1016/j.rser.2011.07.083.
[203] Eichenauer E. Energiekonflikte – proteste gegen Windkraftanlagen als Spiegel demokratischer Defizite. In: Radtke J, Kersting N, editors. Energiewende: politikwissenschaftliche perspektiven. Wiesbaden: Springer Fachmedien Wiesbaden; 2018. p. 315–41.
[204] Fettke U. Etablierte und Außenseiter in der Kommunalpolitik? Eine Fallstudie zu Windkraft in einer badenwürttembergischen Kleinstadt (No. 2018– 03), Research Contributions to Organizational Sociology and Innovation Studies, SOI Discussion Papers. University of Stuttgart, Institute for Social Sciences, Department of Organizational Sociology and Innovation Studies; 2018.
[205] Boos M, Steffen A. Energiewende vor Ort: Bürgerbegehren zum Bau von Windkraftanlagenim Soonwald. In: Glaab M, editor. Politik mit Bürgern - politik für Bürger. Wiesbaden: Springer Fachmedien Wiesbaden; 2016. p. 303–16.
[206] Fettke U. Kommunale Energieprojekte als Lokalpolitikum. In: Radtke J, Canzler W, Schreurs MA, Wurster S, editors. Energiewende in Zeiten des Populismus. Wiesbaden: Springer Fachmedien Wiesbaden; 2019. p. 263–93.
[207] Kamlage J-H, Warode J, Reinermann JL, Vries N de, Trost E. Von Konflikt und Dialog: Manifestationen der Energiewende in den Transformationsfeldern Netzausbau, Biogas und Windkraft. In: Duttmann R, Kühne O, Weber F, editors. Landschaft als Prozess. Wiesbaden: Springer Fachmedien Wiesbaden; 2020. p. 603–33.
[208] Hatzl S, Seebauer S, Fleiß E, Posch A. Market-based vs. grassroots citizen participation initiatives in photovoltaics: a qualitative comparison of niche development. Futures 2016;78–79:57–70. https://doi.org/10.1016/j.futures.2016.03.022.
[209] Hoeft C, Messinger-Zimmer S, Zilles J, editors. Bürgerproteste in Zeiten der Energiewende: lokale Konflikte um Windkraft, Stromtrassen und Fracking, Studien des Göttinger Instituts für Demokratieforschung zur Geschichte politischer und gesellschaftlicher Kontroversen. Bielefeld: transcript; 2017.
[210] Kluge J, Offermann-van Heek J, Ziefle M. How will I know about local energy projects? A conjoint-analysis of communication preferences in Germany. Energy Res Social Sci 2021;75:102016. https://doi.org/10.1016/j.erss.2021.102016.
[211] Schweizer P-J, Renn O, Köck W, Bovet J, Benighaus C, Scheel O, et al. Public participation for infrastructure planning in the context of the German "Energiewende". Util Policy 2016;43:206–9. https://doi.org/10.1016/j.jup.2014.07.005.
[212] Mautz R, Fleiß E, Hatzl S, Reinsberger K, Posch A. Bottom-up-Initiativen im Bereich Photovoltaik in Deutschland und Österreich: rahmenbedingungen und Handlungsressourcen. In: Holstenkamp L, Radtke J, editors. Handbuch Energiewende und Partizipation. Wiesbaden: Springer Fachmedien Wiesbaden; 2018. p. 597–610.
[213] Renn O, Köck W, Schweizer P-J, Bovet J, Benighaus C, Scheel O, et al. Öffentlichkeitsbeteiligung bei Planungsvorhaben der Energiewende. In: Grunwald A, Renn O, Schippl J, editors. Die Energiewende verstehen - orientieren - gestalten. Baden-Baden: Nomos Verlagsgesellschaft mbH & Co. KG; 2017. p. 547–68.
[214] Mirumachi N, Torriti J. The use of public participation and economic appraisal for public involvement in large-scale hydropower projects: case study of the Nam Theun 2 hydropower project. Energy Policy 2012;47:125–32. https://doi.org/10.1016/j.enpol.2012.04.034.
[215] Enke N, Reinhardt I. Akzeptanz durch Beteiligung. In: Bentele G, Bohse R, Hitschfeld U, Krebber F, editors. Akzeptanz in der Medien- und Protestgesellschaft. Wiesbaden: Springer Fachmedien Wiesbaden; 2015. p. 57–74.
[216] Koirala BP, Araghi Y, Kroesen M, Ghorbani A, Hakvoort RA, Herder PM. Trust, awareness, and independence: insights from a socio-psychological factor analysis of citizen knowledge and participation in community energy systems. Energy Res Social Sci 2018;38:33–40. https://doi.org/10.1016/j.erss.2018.01.009.
[217] Liu L, Bouman T, Perlaviciute G, Steg L. Effects of trust and public participation on acceptability of renewable energy projects in the Netherlands and China. Energy Res Social Sci 2019;53:137–44.
[218] Hildebrand J. Vorstellung ausgewählter Evaluationsergebnisse der Konsultationsverfahren der Bundesnetzagentur zu den Netzentwicklungsplänen und Umweltberichten 2023/2024. In: Bundesnetzagentur, editor. Wissenschaftsdialog 2016. Bonn: Tagungsband; 2016. p. 136–45. Bundesnetzagentur.
[219] Ewen C, Horelt M-A. Die Bühnen der Beteiligung. In: Radtke J, Canzler W, Schreurs MA, Wurster S, editors. Energiewende in Zeiten des Populismus. Wiesbaden: Springer Fachmedien Wiesbaden; 2019. p. 391–421.
[220] Mayeda AM, Boyd AD. Factors influencing public perceptions of hydropower projects: a systematic literature review. Renew Sustain Energy Rev 2020;121:109713. https://doi.org/10.1016/j.rser.2020.109713.
[221] Wiedemann PM, Claus F. Was kann eine Informationskampagne zu Vor- und Nachteilen von Erdkabeln gegenüber Freileitungen beim Netzausbau bewirken? Energiewirtschaftliche Tagesfr 2016;66(5):15–9.
[222] Roth K. Die Akzeptanz des Stromnetzausbaus: eine interdisziplinäre Untersuchung der Möglichkeiten und Grenzen gesetzlicher Regelungen zur Akzeptanzsteigerung entlang des Verfahrens für einen beschleunigten Stromnetzausbau nach dem EnWG und dem NABEG. Baden-Baden: Nomos Verlag; 2020.
[223] Wolsink M. Planning of renewables schemes: deliberative and fair decision-making on landscape issues instead of reproachful accusations of non-cooperation. Energy Policy 2007;35(5):2692–704. https://doi.org/10.1016/j.enpol.2006.12.002.
[224] Rowe G, Frewer LJ. Public participation methods: a framework for evaluation. Sci Technol Hum Val 2000;25(1):3–29. https://doi.org/10.1177/016224390002500101.
[225] Stirling A. Precaution, foresight and sustainability: reflection and reflexivity in the governance of science and technology. In: Voss JP, Bauknecht D, Kemp R, editors. Reflexive governance for sustainable development reflexive governance for sustainable development. Cheltenham: Edward Elgar Publishing; 2006. p. 225–72.
[226] Arnstein SR. A ladder of citizen participation. J Am Inst Plan 1969;35(4):216–24. https://doi.org/10.1080/01944366908977225.
[227] Fung A. Putting the public back into governance: the challenges of citizen participation and its future. Public Adm Rev 2015;75(4):513–22. https://doi.org/10.1111/puar.12361.
[228] Wolsink M. Social acceptance revisited: gaps, questionable trends, and an auspicious perspective. Energy Res Social Sci 2018;46:287–95. https://doi.org/10.1016/j.erss.2018.07.034.
[229] Renn O, Schweizer P-J. Nclusive governance for energy policy-making: conceptual foundations, applications, and lessons learned. In: Renn O, Ulmer F, Deckert A, editors. The role of public participation in energy transitions. London: Elsevier; 2020. p. 39–79.
[230] Gao X, Zhou S, Schurr D. Unveiling and explaining the procedural justice in the policy design of renewable energy siting process in the United States. Policy Stud J 2024. https://doi.org/10.1111/psj.12563.
[231] Igliński B, Kiełkowska U, Mazurek K, Drużyński S, Pietrzak MB, Kumar G, et al. Renewable energy transition in Europe in the context of renewable energy transition processes in the world. A review. Heliyon 2024;10(24):e40997. https://doi.org/10.1016/j.heliyon.2024.e40997.
[232] Chilvers J, Pallett H, Hargreaves T. Ecologies of participation in socio-technical change: the case of energy system transitions. Energy Res Social Sci 2018;42:199–210. https://doi.org/10.1016/j.erss.2018.03.020.
[233] Devine-Wright P, Peacock A. Putting energy infrastructure into place: a systematic review. Renew Sustain Energy Rev 2024;197:114272. https://doi.org/10.1016/j.rser.2023.114272.
[234] Smith L. Public participation in policy making: the state-of-the-art in Canada. Geoforum 1984;15(2):253–9. https://doi.org/10.1016/0016-7185(84)90036-8.
[235] Fast S. Assessing public participation tools during wind energy siting. J Environ Stud Sci 2017;7(3):386–93. https://doi.org/10.1007/s13412-016-0419-0.
[236] Walker C, Ryder S, Roux J-P, Chateau Z, Devine-Wright P. Contested scales of democratic decision-making and procedural justice in energy transitions. In: Nadesan M, editor. Energy democracies for sustainable futures. San Diego: Elsevier Science & Technology; 2022. p. 317–26.
[237] Groves C. The bomb in my backyard, the serpent in my house: environmental justice, risk, and the colonisation of attachment. Environ Polit 2015;24(6):853–73. https://doi.org/10.1080/09644016.2015.1067348.
[238] Cowell R, Devine-Wright P. A 'delivery-democracy dilemma'? Mapping and explaining policy change for public engagement with energy infrastructure. J Environ Pol Plann 2018;20(4):499–517. https://doi.org/10.1080/1523908X.2018.1443005.
[239] Lafont C. Democracy without shortcuts. Oxford: Oxford University Press; 2019.
[240] Cuppen E. The value of social conflicts. Critiquing invited participation in energy projects. Energy Res Social Sci 2018;38:28–32. https://doi.org/10.1016/j.erss.2018.01.016.
[241] Looze A de, Cuppen E. To wind up changed: assessing the value of social conflict on onshore wind energy in transforming institutions in the Netherlands. Energy Res Social Sci 2023;102:103195. https://doi.org/10.1016/j.erss.2023.103195.
[242] van de Grift E, Cuppen E. Beyond the public in controversies: a systematic review on social opposition and renewable energy actors. Energy Res Social Sci 2022;91:102749. https://doi.org/10.1016/j.erss.2022.102749.
[243] Suškevičs M, Ehrlich T, Peterson K, Hiiemäe O, Sepp K. Public participation in environmental assessments in the EU: a systematic search and qualitative synthesis of empirical scientific literature. Environ Impact Assess Rev 2023;98:106944. https://doi.org/10.1016/j.eiar.2022.106944.
[244] Radtke J. E-participation in energy transitions: what does it mean? Chances and challenges within Germany's Energiewende. Technol Forecast Soc Change 2025;210:123839. https://doi.org/10.1016/j.techfore.2024.123839.
[245] Santos Ayllón LM, Jenkins KE. Energy justice, just transitions and Scottish energy policy: a re-grounding of theory in policy practice. Energy Res Social Sci 2023;96:102922. https://doi.org/10.1016/j.erss.2022.102922.
[246] Baxter J. Energy justice: participation promotes acceptance. Nat Energy 2017;2(8). https://doi.org/10.1038/nenergy.2017.128.
[247] Hübner G, Leschinger V, Müller FJ, Pohl J. Broadening the social acceptance of wind energy – an integrated acceptance model. Energy Policy 2023;173:113360. https://doi.org/10.1016/j.enpol.2022.113360.
[248] Rand J, Hoen B. Thirty years of North American wind energy acceptance research: what have we learned? Energy Res Social Sci 2017;29:135–48. https://doi.org/10.1016/j.erss.2017.05.019.

[249] Nilson R, Rand J, Hoen B, Elmallah S. Halfway up the ladder: developer practices and perspectives on community engagement for utility-scale renewable energy in the United States. Energy Res Social Sci 2024;117:103706. https://doi.org/10.1016/j.erss.2024.103706.

[250] Giordono LS, Boudet HS, Karmazina A, Taylor CL, Steel BS. Opposition "overblown"? Community response to wind energy siting in the Western United States. Energy Res Social Sci 2018;43:119–31. https://doi.org/10.1016/j.erss.2018.05.016.

[251] Bell D, Gray T, Haggett C. The 'Social Gap' in wind farm siting decisions: explanations and policy responses. Environ Polit 2005;14(4):460–77. https://doi.org/10.1080/09644010500175833.

[252] Pallett H, Chilvers J, Hargreaves T. Mapping participation: a systematic analysis of diverse public participation in the UK energy system. Environ Plann: Nature and Space 2019;2(3):590–616. https://doi.org/10.1177/2514848619845595.