

# Identities, innovation, and governance: A systematic review of co-creation in wind energy transitions

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## Abstract

The concepts co-creation and co-production increasingly find their way into research on renewable energy development. As an innovation paradigm “co-creation” is believed to produce more legitimate and inclusive innovation processes, however, in the context of energy transitions there is still no consistent understanding of what the concept means and implies. This paper investigates the links between co-creation and wind energy development to explore the (potential) role of co-creation for research and practice. We do that through an exploratory systematic review of 51 papers that refer to co-creation and co-production in relation to wind energy development. The review identifies three different understandings of co-creation in the literature, namely co-production of identities and representations, co-creation of innovation in sociotechnical systems, and co-creation as participatory governance. The three perspectives capture how co-creation comes about and how it shapes relations between actors present in the sociotechnical assemblages of wind energy development. We show how the use of the concept of co-creation suggests new roles for citizens as co-creators and co-producers of electricity and planning decisions. We subsequently discuss what these roles suggest for the understanding of participation in renewable energy development and transitions more broadly.

*Keywords:* Co-creation, co-production, participation, social acceptance of renewable energy innovation, wind energy, renewable energy

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## Introduction

A transition to renewable energy production is key if we intend to reduce greenhouse gas emissions by 80–95% by 2050,<sup>1</sup> as promised by the European Union [1]. The implementation of renewable energy generation capacity has risen steadily since the turn of the millennium, and in 2019, renewables accounted for almost 25% of global power output [2]. Nevertheless, further expansion of renewable energy continues to face local contention, and many attempts at developing greater capacity (particularly for wind power) are still curtailed before these attempts can reach implementation. Scholarly literature on wind energy development often investigates this as a matter of (lacking) social acceptance at a community, market, or socio-political level [3]. In particular, the public has been seen as a barrier to wind development, and early research on social acceptance has particularly focused on finding ways to overcome this “roadblock” [4,5]. Subsequently, research on social acceptance has diversified to include perspectives more nuanced than the “not in my backyard” (NIMBY) characterization of opposition [6], with an increased focus on the relations among the involved actors [7]. This implies that the object of study is not simply a question of social acceptance or rejection but rather one of innovation and of sociotechnical relations and processes more generally. To grasp these processes fully, we must investigate a number of different coexisting dimensions, such as community life and everyday experiences, socio-political configurations of power structures and governance, and market formation and exchange mechanisms [7–9].

However, as Devine-Wright et al. [8] state, only rarely do empirical studies of renewable energy projects actually engage with more than one of these dimensions—community, markets and socio-political aspects—at a time, and public participation approaches focused on information and consultation are still the most predominant in actual development practices [10].

Furthermore, “fixed, pre-given meanings of what it means to participate” [11] and the traditional focus on overcoming barriers to social acceptance arguably still echo in the research due to the literature’s sustained attention to the public and its perceptions and responses [11–13] and its participation [10,14,15]. In the face of controversy over wind power development, it is somehow

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<sup>1</sup> Compared to 1990 levels.

still assumed that “more,” “better,” or “deeper” participation, with a focus on deliberation and grounded in a better understanding of justifications for opposing particular wind energy developments, will lead to socially acceptable outcomes, although some papers have discussed the implicit assumption that consensus is to be the outcome of such deliberation [4,10].

In this paper, we start from the observation that various attempts at adjusting the understanding and practice of public participation in the face of controversies over wind energy have not solved the problem of public discontent. We propose that these difficulties are related to the way by which social relations of participation continually conceptualize the engagement of one party (publics<sup>2</sup>) in something (development projects) by another party (developers) based on the interests of this latter party or of society at large. This conceptualization is an obvious fit with the current planning systems of many countries that assign the initiative and the responsibility of wind energy development to authorities and/or developers. However, this conceptualization has two important limitations: first, it tends to treat the social context (including various publics) as separate from technical development, and second, it does not necessarily consider the interests on behalf of groups of publics and other stakeholders in sufficient depth. The research thereby misses an opportunity to understand how publics, in their various forms, can constitute an integrated and value-adding part of the development of wind energy rather than remain mere onlookers who only react to technical developments.

We have therefore turned to the concept of co-creation, which we broadly understand as the coming together of actors across organizational boundaries to create mutually beneficial outcomes, to explore how co-creation might be conducive to wind energy development (and energy transitions more generally), as some scholars have suggested [16–18]. Studies in other fields have argued that co-creation widens the space for innovative developments by including additional and more empowered actor roles and institutional arrangements [19–21]. We therefore

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<sup>2</sup> “Public(s)” is a much-debated concept in the social sciences. In this paper, we primarily use “publics” to designate the collective of citizens in a given democratic constituency, whether that be local, national, or along other lines of demarcation [96]. Many years of research in science and technology studies have demonstrated the necessity of representing the public not as singular but rather as multiple and as particular to specific issues, and of representing it as processual and emergent in the sense that issues spark publics into being [110].

suggest that a focus on co-creation might also prove to be beneficial in relation to wind energy development.

The concept of co-creation has been employed in relation to wind energy, but there is a lack of systematic attention to what it means in this context and how it can be employed. We have therefore conducted a systematic review of the literature on co-creation in wind energy development. During the initial scoping phase of this review, we found that the concept of co-production is often closely related to the use of co-creation [22] and that systematic reviews in other fields have found that these two concepts are often used as interchangeable [19,23]. We have therefore chosen to include both co-creation and co-production in this review, and we view them as overlapping to the extent that we can investigate them together. While some scholars use co-production in a distinct and specific way [39], others do not distinguish systematically between the two concepts. One differentiation is found in Torfing et al. [24], who suggest the conceptualization of co-production as the process through which providers and users of a product or service work together in its production and delivery [24,25]; this study also advises the view of co-creation as a more general concept that designates processes in which different actors come together to solve a shared problem in a way that adds value for all [21,24]. However, we do not find this differentiation to be clear-cut in the reviewed literature and have therefore chosen to include both terms in the search parameters. In the analysis, we refer to the concept used by the particular literature discussed, but in the methodology and discussion section, we use the concept of co-creation to be consistent.

The paper and review has two objectives: first, we consolidate current research on the topic, its applications and objectives, and second, we discuss how a focus on co-creation can be useful in responsible wind energy innovation. In doing this, the paper answers the following research questions guiding the literature review: *How is co-creation used in the literature on wind energy development? Who are the central actors? What are the objectives of co-creation?* The overall purpose of the paper is to investigate the usefulness of the concept of co-creation for the study and practice of wind power development and, particularly, how co-creation adds to the theoretical understanding of social acceptance and participation.

In the next section, we present the context and background for the concepts of co-creation and co-production. Second, we present the systematic review methodology and the research strategy employed in the data production. Third, we present the results of the literature review and establish a shared understanding of how the concepts are applied in the context of wind energy development. Fourth, we discuss what this means for our understanding of agency and actor roles within wind energy development. Our conclusion summarizes how co-creation can improve the study and practice of wind energy development.

## Conceptual and methodological framework

The concept of co-creation has gained traction over the last two decades, and in 2014, it was proclaimed as a new paradigm in business and management studies [21]. Simultaneously, the European Union has promoted co-creation as an innovation paradigm [26], and co-production has been suggested as an approach to create higher quality in public service delivery [20] and in public sector or social innovation [19]. The introduction of these concepts addresses the fact that many attempts at innovation in science and technology fail because societal values and needs are not substantially integrated into products and services. As a way toward more responsible and inclusive innovation processes, the co-creation paradigm suggests that actors come together across organizational and institutional boundaries jointly to create innovations that are mutually beneficial.

Within business and management studies, the shift to co-creation entails that private sector innovation is changed from an intrafirm exercise to a creative collaboration that involves both insiders and external stakeholders, particularly end-users [21]. This shift serves two purposes. First, companies and organizations face increasing challenges to produce goods and services more efficiently if they are to maintain competitiveness in global markets. To overcome this challenge, consumers, as user-innovators, overtake parts of the production activities [22,27,28]. Second, co-creation provides a possibility to add extra value to the products and services, thereby improving an organization's competitive advantage [29]. Hence, customers are not only involved as test subjects who can react to product developments controlled and managed by a designer, but rather as people with insiders' knowledge of how products should be developed to fit their

own needs. In this way customers can provide organizations with insights that can feed directly into product and service innovation.

In public service delivery and public sector innovation, co-creation is understood to aid the public sector in times during which many countries face demographic challenges and budget austerity by improving the effectiveness of and satisfaction with public services through solutions tailored to meet the wishes and values of its users [19]. In the context of renewables, this could mean that the aim of project development is for developers and local communities to explore possibilities together to ensure a form of cooperation that local communities experience as meaningful [30]. Simultaneous satisfaction of citizens' expectations and adherence to tight budgets requires new methods, and when subscribing to the approach of co-creation, some activities can be redistributed for citizens to manage. The prospects of delivering services with lower costs and higher level of satisfaction among citizens, has also been a motivation factor in local government support for community ownership of energy projects [31]. The literature on public service delivery and the use of co-creation and co-production in public innovation typically has its roots in the work by Nobel laureate Elinor Ostrom and colleagues [32], who define co-production as "the process through which inputs used to produce a good or service are contributed by individuals who are not 'in' the same organization" [33]. In this way, the processes behind public service delivery obtain a sensitivity toward different groups of actors, develop an improved focus on achieving jointly desired outcomes, and alleviate some of the pressure on public budgets.

In summary, co-creation can be understood as the coming together of groups of diverse actors across organizational divides with the aim of creating, producing, or improving products [28,34], processes, and services [33] or more generally create value [21] that is desirable for all involved parties. It is a central characteristic of co-creation that end-users are not only involved in providing input to the design-process of the producer but also take part (ideally with all actors as equals) in defining both problems and solutions because a shared outcome is perceived to add the most value for all. In light of the widespread appraisal of co-creation, the concept may also be useful in the development of wind energy where questions of acceptability and public participation have been central. Although the research on public participation in general is



expansive, co-creation, as a particular form of participation, has not received as much attention. Accordingly, this review engages more deeply with the emerging theme of co-creation and its use and uptake in the literature.

## Methodology

To examine how co-creation is used in relation to wind energy development, we have conducted a systematic literature review that improves the evidence base of a field through compilation of existing knowledge [35]. Tranfield et al. [36] recommend a preliminary scoping study to assess the relevance of the review and establish proper search terms. The scoping study for this review included literature on related concepts, including social acceptance, public participation, spatial planning, co-creation and co-production in public service delivery, and public sector innovation and management. The scoping study supported the need for a systematic review specifically focused on wind energy. Due to inspiration from literature reviews from other fields, such as public sector innovation and service delivery [20,23], the scoping study also involved initial test searches using the terms “co-design,” “co-management,” and “co-governance.” We found that the concepts of co-creation and co-production were the most comprehensive and that together they included various forms of citizen involvement discussed under the heading of the other terms [19]. Following the preliminary scoping study, we developed a protocol to guide the review and ensure it was performed in a transparent and replicable manner, as is central for systematic reviews [35,37]. The protocol is summarized in Table 1.

<b>Search terms</b>	Co-creat* OR cocreat* OR “co creat*” OR co- produc* OR coproduc* OR “co produc*” AND “wind energy” OR “wind power” OR “wind park” OR “wind farm”
<b>Databases</b>	Web of Science, Scopus, EBSCOhost, and Science Direct
<b>Period of data collection</b>	May 7, 2019, to October 1, 2019
Study eligibility criteria	
<b>Inclusion criteria</b>	Full-length, peer-reviewed, published articles of studies <ul style="list-style-type: none"> <li>- Using co-creation and co-production in relation to social phenomena<sup>3</sup></li> <li>- Focusing on all aspects of wind energy development</li> <li>- With all kinds of research designs</li> </ul>
Report eligibility criteria	
<b>Period of data publication</b>	No restrictions
<b>Publication outlets</b>	Peer-reviewed journals
<b>Language</b>	English
Results	
<b>Initial sample size</b>	1517 <sup>4</sup>
<b>Papers included in review</b>	51

*Table 1. Review selection criteria*

Data was produced by searching the electronic databases using the search terms and combinations mentioned above. The last search was performed on October 1, 2019. Because the literature sample on co-creation and co-production in relation to wind energy development is relatively small, the second keyword search string (“Wind power” OR “wind energy” OR “wind

<sup>3</sup> Wind energy and co-creation/co-production does not have to be central to the arguments of the studies but the co-production aspect had to relate to social phenomena and not to technical aspects.

<sup>4</sup> The same search terms are run in four different databases, meaning that the initial sample includes a large number of duplicates that have been discarded manually.

park” OR “wind farm”) was kept broad to catch as many results as possible. There was one disadvantage of this decision: because co-production is also used to describe the simultaneous production of two or more specific products, such as forms of energy, the searches returned a large share of false-positive results, which were discarded manually by reading through the titles and abstracts. The screening process resulted in the inclusion of 51 records, 25 of which featured “co-creation,” 22 of which featured “co-production,” and four of which featured both terms. The process of inclusion and exclusion of records is visualized in the flowchart in Appendix A.

### Synthesis method

Because the aim of the review is to investigate the potential usage of a concept that is loosely defined and only just starting to be present in wind energy development, we follow a thematic synthesis approach, which is useful for understanding the relation among different themes and a specific analytical unit [38]. The analysis was performed by importing all 51 documents into a qualitative coding program (ATLAS.ti) and coding each mention of co-creation in vivo. Thus, a number of first-order concepts were produced, such as “co-creation as a way of establishing impact assessment guidelines by/for a diverse community.” We then grouped the first-order concepts into more generalized second-order themes (e.g., “co-creation of guidelines” and “co-creation of/for decision-making”), which we then again aggregated into the more overarching “perspective” of “co-creation as participatory governance.” The process was iterative, shifting back and forth among first-order codes, themes, overarching perspectives, and the original literature. A visualization of the data structure can be found in Appendix B. In the following, we unfold the results of the analysis by describing the three overarching perspectives that we identified.

### Analysis: Three perspectives on co-creation

In this section, we first present overall characteristics of the body of literature on co-creation in wind energy development and subsequently describe each of the three perspectives, which collectively summarize our in-depth thematic analysis. The systematic review resulted in inclusion of 51 papers distributed across 28 journals. Journals on different aspects of energy

account for almost 50% of the publications; the rest of the papers are spread across journals that cover a broad range of subjects, such as ocean management or volunteering, thus indicating that co-creation cuts across and involves themes relevant to different disciplines. An overview of the included papers is found in Appendix C, where we have categorized each paper according to its dominant perspective on co-creation. Some of the papers fit within more than one category, but our final categorization is based on a judgment of what perspective is most dominant in light of the research questions. The three perspectives on co-creation found in the literature are the following: co-production of representations and identities (Perspective one), co-creation of innovation in sociotechnical systems (Perspective two), and co-creation as participatory governance (Perspective three). These three themes are interrelated and partly overlap. Approximately one-sixth of the papers are grouped under the first perspective, one-third are categorized under the second perspective, and roughly half of the papers reflect the third perspective.

The position of “wind energy” in the literature varies; sometimes, wind energy is central to the analysis, as in cases concerning collaborative planning of wind energy projects, while other studies refer to a larger framework and engage, for instance, with changes in energy systems and consumer relationships as facilitators for integration of more wind energy into the energy system. Further studies use co-creation to describe more overarching phenomena, such as changes in the role of voluntary work in civil society, and draw upon examples related to wind energy. This difference reflects one of the overall outcomes of the analysis, showing that co-creation is an approach that can work at different levels. In the following three sections, we present an in-depth analysis of the three overarching perspectives on co-creation, and we start with the literature that incorporates the first perspective.

### **Perspective one: Co-production of representations and identities**

A relatively small component of the reviewed literature primarily uses co-production in alignment with more general theories on the relationship between technology and society for instance by Jasanoff [39] and Law and Callon [40]. According to this approach, an understanding of knowledge generation should not give primacy to social or to techno-scientific knowledge but rather treat them as integrated and mutually constituting knowledge and society. On the basis of

this principle of symmetry, the papers critically dissect how place, people, representations, identities, and experiences are co-produced in the context of wind energy developments [41–45].

The literature analyzes how landscapes with wind energy developments and experiences of them are co-produced by the technology in question, a particular socioeconomic situation, the representation of various actors, and numerous more aspects. A central argument is that wind energy developments not only alter the landscape and the technical infrastructure but also co-produce particular representations of communities and identities of actors and influence the way by which these actors live and understand both themselves and the landscapes that they inhabit. Wind energy is shaped by the local network of material configurations and social representations, but it simultaneously alters this network in the process of co-production.

The introduction of these technologies can create particular kinds of (empty) landscapes [41] as well as individual and collective identities [42,44]. They can, for instance, support “green” tourist experiences [43] but also configurations of “the public” [45] that shape the way in which local areas, life-trajectories, and the energy transition develop. One paper argues that the development of wind farms in rural areas, legitimized through the mobilization of the derogatory image of “outskirts Denmark,” reproduces structural inequalities through the clearing of more land and the displacement of more people [41]. Another paper describes how wind energy co-produces a noise-polluted landscape of unsellable property alongside residents who start to self-identify as “tied pigs” (tied by unsellable property) [42].

The literature also shows how the planning of wind farms and the models behind nature conservation, which guide some aspects of wind energy planning, do not constitute representations of the truth but rather work as “serviceable truths” that are highly contingent upon estimates and predictions [46]. Rather than laying a foundation for a governance regime founded in a general objective truth, what laws and models (co-)produce is a “good enough” approximation of the truth that can provide a basis for legitimate governance and decision-making [46]. Thus, the measures laid as foundation for planning provide actionable knowledge in the form of models used for prediction and governance. These models, the literature argues, inform decision-making, shape planning, law, and governance and thereby play a role in co-producing technological advancement and society more generally.

In summary, the application of co-production in these articles argues that wind energy development not only comes with physical, technical, or spatial implications but also equally implicates peoples' identities and the way that they understand their social and material conditions. The physical, technical, spatial, social, epistemological, and democratic dimensions cannot be separated but instead co-evolve [47]. Accordingly, the literature subscribing to this perspective demonstrates how assemblages with wind energy-producing technologies and distribution markets do not emerge in a vacuum. These assemblages are instead intertwined in a multitude of diverse and often conflicting economic, social, and political forces; as Delina [48] states, navigating these sociotechnical realities should be expected "to be turbulent and highly contested." The literature representing this perspective is predominantly descriptive, a quality that distinguishes it slightly from the second and third perspectives, which are at times prescriptive and pose suggestions for how co-creation can be operationalized in practice.

### Perspective two: Co-creation of innovation in sociotechnical systems

A number of papers in our collection focus on the co-creation of sociotechnical systems. This can be focused on technological innovation and development of market mechanisms, the preparation of sociotechnical transitions, and the uptake of wind energy technology in existing markets. In most cases, the literature takes a retrospective approach and analyzes how wind energy markets and industries were established, but the literature also features examples of future-oriented pieces that present suggestions for how new trajectories for energy systems should be co-created.

This group of papers uses co-creation to describe the sociotechnical relationships at the core of changes in industrial sectors and markets. As an example, it is argued that co-creation of heterogeneous resources (e.g., technology design, supplier competencies, user preferences, and support for research and development) and collective learning processes were central in the emergence of the Danish wind turbine cluster [49]. Other papers assert that active users co-create value and adjust energy systems by informing about "needs, desires, habits and plans" [50] and that the co-creation of a German feed-in tariff by NGOs and industry associations became a backbone for technology development in Germany [51]. A third group of papers describes how

co-creation between large enterprises and small and medium-sized enterprises, or SMEs, can lead to enhanced competitiveness of the offshore wind sector by lowering the levelized cost of energy [52,53]. While the argument about the German feed-in tariff and competitiveness of the offshore wind industry concerns how institutional structures positively affect wind energy technology, the primary focus of the Danish wind energy cluster example is on micro-processes to show how innovation processes are not linear but are rather shaped through bottom-up initiatives and participation. Such analyses are focused on the institutional level of wind energy developments, how ingrained ways of doing things in energy systems or markets can be altered, and how processes of co-creation can add value [52,53].

Many of the papers point to institutional barriers (such as carbon lock-in, contract periods, risk-taking profiles, and lack of openness [52]) and a lack of trust as conditions that increase the difficulty of transitioning to more collaborative forms of interaction and organization. This is true in connection to relations between industry-actors but also more generally with regard to the organization of the entire energy system. One example of how these barriers are managed is the study of the emergence of the Danish wind turbine cluster. In this connection, “translation” of disinterested and hostile forces alongside the enrollment of outsiders led to changes in identities and relations that resulted in an ability to imagine alternative futures [49]. This development was facilitated by bottom-up initiatives that were weaved together with existing industries, actors, and other resources in arenas, or “hybrid forums,” making space for all.

It is not uncommon for parts of the literature on sociotechnical systems also to be prescriptive and to suggest alternative perceptions of how markets and sociotechnical systems of energy production, delivery, and consumption could be organized and co-created in the future. These alternatives aim at creating new markets [54], balancing the relation between production and consumption in (distributed) energy systems [17], assisting central institutions in service delivery, [55] or creating economic and productive systems focused on alternative values such as de-growth and communitarian principles [56,57]. This reconfiguration of the mode of production both in terms of electricity and infrastructure typically serves as a means of empowerment for citizens, more autonomy in the system, and new forms of value creation.

The papers grouped under this perspective thus present different roads to such future co-created systems, for instance, household production of energy in distributed generation systems [58] or groups of citizens coming together to produce energy locally through cooperative ownership of a wind turbine [55,59]. Another example is a “design globally, manufacture locally” movement, which gives practical instructions for how locally to manufacture small turbines for off-grid electricity generation by following simple design guidelines [56]. Despite the different scales and approaches, all the suggestions focus on processes of co-creation that are material by nature and include the active involvement of citizens in production and/or delivery of a product or service. These alternative forms of participation and ownership also imply that the roles of citizens change from mere consumers, users, or citizens to co-producers, co-creators, or prosumers (i.e., producer consumers) who actively shape products and services rather than just use or accept them (or the opposite) [5,56,60].

Overall, the literature representing this perspective shares the idea that co-creation can be a facilitator of innovation by involving alternative actors in the system and by creating the possibility for new relations and roles, which reconfigure the sociotechnical system. The change from a passive consumer to an active co-creator of energy production could materially involve local citizens and give them a constructive stake in the development of the energy system. The literature expands the networks of wind energy development to include a broader configuration of actors, expanding the available roles to feature more than just publics and citizens, and encourage co-creation because it distributes agency. Integration of the specialized knowledge and various interests, creativity, and skills of different actors is expected to add substantively by creating more socially robust and successful innovations that create value for all. Hence, co-creation not only concerns knowledge production but also development of renewable energy systems and the configuration of the sociotechnical assemblages of the future.

### **Perspective three: Co-creation as participatory governance**

The remaining and largest component of the literature focuses on how governance (structures) can be co-created among different actors. In this context, co-creation is usually defined in a



pragmatic and operational manner and oriented toward problem-solving efforts in specific situations where actors try to create more legitimate, socially just, and efficient processes [52,61] or to remedy conflicts and problems [62,63] by applying co-creation as a governance instrument. One exception to this pragmatic use is Chilvers et al. [9], who propose a whole new conceptual framework for participation in sociotechnical change based on co-production. We return to this framework in our discussion.

The areas of application of co-creation as a tool for governance vary and include spatial planning and siting of projects [64–66], multi-use of offshore space [62,67,68], community energy and benefits [63,69,70], collaborative research (co-)production [71–74], and climate prediction models [75]. The papers representing this perspective all concern processes connected to wind energy development that are eased or optimized through co-creation. This is often related to perceptions of justice exemplified by an increased focus on recognition and inclusion of (all kinds of) people living in proximity to wind energy developments [64,76]; trust in processes and institutions [63,77]; sensitivity to and alignment with social values, norms and beliefs [62,63]; or social learning and the ability to exert influence [63,78,79]. Around one-third of the papers included in this perspective have an explicit focus on social justice and consider the employment of co-creation as closely connected to the creation of a socially just energy transition. However, we also find a reasonable amount of papers emphasizing the value-adding aspects of co-creation, such as improved business-models, [62,67,68] in addition to justice-oriented arguments.

Ubiquitous among the papers is a recurrent theme of attempting to improve social acceptance by co-creation, and we find that some of the literature considers co-creation as a particular kind of participation. For instance, Chen states that, in connection to the planning and development of offshore wind farms in Taiwan, stakeholders (traditional ocean users, aquaculture farmers, and fishers) were only involved in consultation and therefore “did not completely participate in the launching and pre-planning of OWF projects to be co-creators” [67]. Others refer to co-creation as a foundation for *more* participative models [61] without directly mentioning what this “more” entails. However, it seems to refer implicitly to the status of knowledge in the participatory processes; many authors stress how models based on co-creation establish more equal relationships among contributions from all involved parties [63,65,80]. The rationale is that citizens who have been involved as co-producers of decisions in open planning processes will be

less opposed to renewable energy infrastructures when they have taken part in creating the frameworks for planning, implementation, and development because their values are considered and included in decisions, plans, and processes [17,77].

At the same time, however, the papers exhibit a diverse set of objectives behind co-creation and its explicit or implicit relationship with social acceptance of wind farms. Some papers seem to focus on instrumental [81] reasons and see co-creation as a useful way of creating legitimacy [67,82], while others focus more on normative reasons, believing that co-creation and particularly citizens' ability to exert influence are inherently valuable [63,76]. Additional papers focus on substantial reasons, asserting that co-creation creates better sociotechnical solutions because the utilization of the special capabilities of all involved actors will create better results with more value added [52,83]. Importantly however, many papers conflate and only indirectly reveal these reasons.

The literature is also diverse in providing specific descriptions of how co-creation supports acceptance. While some papers only mention co-creation as a possible approach, without delving into further detail [84], others argue that the ability to “exert influence and correct decisions” improves satisfaction [78] or that involvement must occur earlier, in the initial phase of deciding the framework [67]. Some papers describe how to orchestrate the process to increase trust in institutions [77] and suggest specific improvements, such as the implementation of a collaborative governance model focused on ongoing deliberation and inclusion of “even the least powerful stakeholders” [64] or active participation in co-producing boundaries for inclusion in community benefit schemes [70]. The themes and discussions are similar to those found in literature on social acceptance focused on public participation [10,14]. In this context, it is possible to argue that some uses of co-creation are comparable to the idea of optimizing participation by fine-tuning the processes of participation and, thereby, reaching a new top rung of the ladder(s) of participation [85–87].

However, compared with existing literature on public participation and social acceptance, the literature on co-creation differentiates itself by employing a broader focus than simply “the public” and including a more diverse group of actors, such as companies [68], (non-profit) organizations [83], and (environmental justice) movements [88]. This is related to a wider

perspective that includes value creation and business models alongside the question of social acceptance. For example, it is argued that acceptance of cumulative impact assessment guidelines was the result of co-creation [82] and that co-creation between companies and sector experts led to robust assessments and improved business value propositions in the offshore wind sector [68]. The reason behind these benefits is that different actors have different capabilities, which are all relevant for the innovation process, and that these capacities will be best utilized if all actors with an interest in the process or project are included equally in the innovation network.

The papers representing the governance perspective, however, also acknowledge problems with the integration of different kinds of actors and their various backgrounds, interests, and approaches to knowledge production. Many authors therefore suggest the involvement of mediators and analyze cases in which such mediators have made a difference. A mediator can come in many forms, such as boundary organizations, knowledge brokerage institutions [61], or community liaison committees, but are all supposed to help overcome the barriers between different interests and kinds of expertise to create more robust foundations for decisions [65,80]. A central element in connection to such boundary organizations seems to be these organizations' level of engagement; sometimes, boundary organizations are allowed to help run participation initiatives actively (i.e., facilitate co-production), [89] while mediators have been used in other cases only for one-way communication from developer to communities [80]. However, boundary organizations are often considered helpful in building trust among local communities because these third-party organizations are seen as more objective and disinterested in the outcome.

In summary, the literature on co-created governance of wind energy developments revolves around many of the same themes as those found in the public participation oriented part of the literature on social acceptance of renewable energy innovation. We see this particularly in the analysis and discussion of procedural justice, the extent to which procedural justice is present, and in the attempt to do participation differently. However, the literature has a particular focus on sensitivity toward values, norms, interests, and publics' ability to exert influence as a lever for social justice. Inclusion of citizens (and other actors) is encouraged to occur before particular

projects are conceptualized so that these actors become part of the formulation, conceptualization, and design instead of mere occasional consultants.

## Discussion of the three perspectives on co-creation in wind energy development

Broadly defined, the concept of co-creation can denote the creation or production of something with input from people “who are not ‘in’ the same organization” [33], though many authors specify this external someone to be the end-user of the product or service [19,21,32]. Just as Ostrom describes, the literature included in this review focuses on how innovation can result from “crossing great divides” [33] between the social and technical, experts and lay people, and prosumers and systems of centralized energy production. The first perspective on the co-production of representations and identities shows how the social and technical are inextricably intertwined and co-produced. We find this argument running through the papers representing the other perspectives as well, for instance in the commitment to assigning equal weight to different kinds of knowledges in the co-created governance of specific projects. It is also fundamental in the sustained attention to all the heterogeneous, human, and non-human elements that co-create system innovation and in the focus on more material ways to participate, as evident in the idea of prosumption or local ownership of energy infrastructures. These new roles for citizens reconfigure the sociotechnical system, and vice versa. Table 2 summarizes the findings of the analysis and constitutes the foundation for our subsequent discussion. In the remainder of this section, we will consider how the three perspectives can add to literature on public participation in wind energy development.

	<b>REPRESENTATIONS AND IDENTITIES</b>	<b>INNOVATION IN SOCIOTECHNICAL SYSTEMS</b>	<b>PARTICIPATORY GOVERNANCE</b>
<b>WHAT DOES CO-CREATION MEAN?</b>	A way of understanding the sociotechnical world where knowledge, values, and material things are intertwined.	A(n analytical) tool to understand how changes in sociotechnical systems (can) happen.	An approach to organizing social relations in concrete project development.
<b>WHO CO-CREATES?</b>	All (human and non-human) actors who can be included in the network as relevant.	Incumbent and alternative/“outside” actors. Citizens often take part based on their capabilities and skills as owners, co-operative members, activists, and prosumers—not simply as citizens being consulted.	Most commonly developers, authorities, and local communities. Focus not only on involving “the public” in participation processes but rather on a wider set of actor groups such as movements, companies, organizations, and other actors with an interest in the project/process at stake.
<b>HOW AND WHY DO THEY CO-CREATE?</b>	Continually: explicitly and implicitly, intentionally and unintentionally.	Creating a new configuration of sociotechnical systems by materially producing or creating something (e.g., electricity or small-scale turbines). Based on individual interest in performing different tasks related to the energy system.	Attempting to give equal weight to incumbent and alternative values/perspectives and focusing on social learning and what is mutually beneficial. Often concerns knowledge formation and can involve boundary organizations.

*Table 2. Overview of the different understandings of co-creation and actor relations.*

### Co-creation, legitimacy, and the inclusion of various interests

The first aspect we wish to draw forth from the literature concerns how co-creation can be beneficial in relation to specific projects or facilitation of processes related to wind energy development. The argument in this section primarily relates to the literature clustered under the

third perspective, co-creation as participatory governance, and also has commonalities with public participation literature. In comparison to more traditional participation processes in which citizens are invited to “closed” [90] deliberative spaces characterized by a technical-regulative framing [91], we suggest that a co-creation approach can be more sensitive to—and better include—different interests and values. A central difference is that actors should be involved earlier [77] and that efforts should be made to treat various actors and the kinds of knowledge and perspectives that they contribute more equally than in the traditional participation processes. Comparison with Callon’s [92] three models of participation (of laypeople in science) might help to elucidate this.

The three models describe different approaches to the formation of knowledge through public education (M1), public debate (M2), or co-production (M3) [92]. Instead of looking at local knowledge as something that has to be improved through education (M1) or something that is activated with the sole purpose of enriching scientific (or expert) knowledge (M2), the co-production model suggests that, to overcome the gap between experts and laypeople, knowledge has to be the product of one single process involving collaboration among all actors [92]. Instead of simply adding laypeople’s knowledge as an extra layer to decision-making (M2), relevant knowledge must be negotiated from the outset, treating knowledge of the social context (e.g., landscape values and representations [93] or social relations, justice, and trust [94,95]) as equally important as technical competences in finding the “right” solutions. This approach is evident in several of the studies that emphasize how power dynamics need to shift so that, instead of being recipients of information (M1) or deliberating publics (M2), “publics” act as (co-)producers of knowledge and governance structures [52,63,64,76,89].

As such, co-production can be seen as a particular way of attending to different interests, values, knowledge, and practices that create robust compromises by focusing on (partly) shared goals and benefits. While the traditional notion of participation has connections to an ideal of democracy in which citizens come together to deliberate on issues of common interest, the notion of co-creation more directly addresses citizens as actors with different kinds of interests guiding their participation. Actors should not, as sometimes suggested in participation literature [96], set aside their personal interests to agree on the common good. Rather, it is precisely

because they have different interests that the local residents, businesses, communities, and organizations should be integrated into the process. Here, we align with Chilvers et al.'s [9] ambition of challenging traditional conceptions of the subjects, objects, and models of participation to articulate systemic understandings of participation based on the notion of co-production. In this endeavor, the potential roles of actors are important, a point upon which we elaborate in the next section.

### Citizens, users, and other competent co-creators

Instead of regarding relevant actors as “supporters” and “resisters,” or as “adopters,” “consumers,” and “users,” as social acceptance literature tends to view these parties [97], our review suggests that we might benefit instead from looking beyond these usual subjects when listing potential participators. Rather, we should focus on how actors actively shape technologies, procedures, and other elements to fit better with their reality. According to the literature, this often happens “not by deliberating, voting or bargaining” but rather by actively participating in realizing specific projects, such as by financing a wind turbine through a cooperative [59,98] or compiling design manuals for small-scale turbines and helping others with constructing these turbines [56]. In this way, citizens can affect their individual and collective life situations by participating in society through various roles.

In the literature, this manifests in the variety of different actor positions involved in co-creation related to aspects of wind energy. Examples are non-governmental organizations [51], SMEs [52,53], small-scale aquaculture farmers and fishers [67], prosumers [11,58,84], wind turbine owners [59], and manufacturers [56] who all take part in processes based on their interests and capacity (and wish) to add value to a given process or project. Focusing on co-creation of robust compromises highlights that identities, interests, and roles in a network are not “pre-given and static” [9], such as the “citizen” or “consumer” labels and standard procedures for public participation have a tendency to imply. Instead, when negotiating a robust compromise, an actor can assume many identities and interests contingent on each situation and how the process develops. Actors’ roles continuously shape and are shaped by the networked relations such that the actor is more than a “citizen,” “neighbor,” or “user,” dependent on what kinds of relations

and resources they can mobilize. This approach also enables actors to pursue their interests openly because these interests are acknowledged as legitimate.

Thus, the actors involved in co-creation all represent particular interests, capacities, and material practices. Emphasis is placed on the capabilities of different actors and how they will be best utilized if actors are included equally into the innovation network. Importantly, actors' roles and identities can change over time. For instance, it is possible to turn opposition groups into collaborators, co-creating a solution that is sensitive to local contexts and values. Another example is that actors opposed to values inherent in centralized energy production co-create a system more fitting to them by producing a new set of turbines suitable for off-grid household energy production, thereby changing their own roles from end-users to prosumers. This diversification of actor positions has implications for the ways in which actors engage with wind energy development such that co-creation can be seen as attempts at opening other spaces for participation in sociotechnical systems. We expand on this in the following section.

### Material participation, bottom-up initiatives, and the performance of alternative systems and futures

The literature on co-creation demonstrates how actors attempt to create new and diverse spaces for participation, which allows them to assume a variety of identities and roles. Actors accomplish this, for example, by creating alternatives to large-scale corporate ownership through cooperatives [55,59], promoting distributed generation and prosumption [58,84], or creating alternative parallel systems of off-grid energy production [56]. Our second perspective illustrates how it can be a struggle to configure the sociotechnical relations of future energy systems and for actors to be involved in making and performing these systems in material ways. Such actors attempt to carve out niches for themselves and their peers, which allow them to co-create and perform the energy system development from below. This also reconfigures the relationships between suppliers and consumers: suppliers become dependent on consumers as potentially competing energy distributors, and consumers and suppliers become dependent upon the same (grid) systems for delivery, market structures, and other institutions.

The literature on co-creation has a strong focus on these sociotechnical aspects and illustrates how technical hardware [99,100] constitutes critical nodes in the networks of wind energy as a



technology, a sector, and a social practice. Concurrently, the literature stresses the argument that non-human entities have agency and can be conceived of as actors [101] and shows how this perspective obliges us to ascribe “equal importance to the role of technicians, politicians, and end-users as [well as to] the functionality of generators, inverters, and batteries” [99]. Technical factors such as landscapes, wind resources, small or large-scale wind turbines, and energy systems affect the possibility for energy delivery, but so do social infrastructure and the configuration of identities. The literature demonstrates that residence in isolated rural areas engenders the manufacturing of off-grid household wind turbines that are better suited to local needs than those available on the market, while simultaneously promoting a political economy rather different from that of growth-oriented mass production [56]. Thus, the literature emphasizes that co-production is always-already there as a factor in wind energy developments, as shown in the first perspective.

To take part in actively co-creating the systems of wind energy development, actors need to mobilize certain capabilities and networks, and therefore, certain sociotechnical configurations facilitate alternative (e.g., small-scale) actors to emerge, while other configurations hinder them [102]. Taking part in wind energy development under the politico-economic, technical, and industrial circumstances connected to large-scale turbines, projects, and production requires that actors are capable of mobilizing far longer networks (e.g., accessing capital, lawyers, and technical expertise) than those that were required when the sector was in its infancy. Several of the cases described in the analysis point to the importance of actors emerging outside existing institutions and networks, thereby suggesting that opening up networks to new actors might serve as a catalyst for innovation in these sociotechnical systems [49,51].

In summary, understanding sociotechnical systems as co-created suggests that publics should not primarily be seen as consumers or as citizens to be consulted but rather as creative, capable, and skillful co-creators and innovators in the transition toward more sustainable energy futures [103–105]. This appreciation of competent co-creators is also evident in the EU’s recent ambition to explore the “new wave of public engagement, where co-creation is the key notion” [106] and in the intensified focus on collective experiments with or by the public in, for example, living labs

[107,108], emphasizing that participation can take many more forms than those imagined in traditional planning systems and policies.

## Conclusion and further research

Throughout this review, we have shown how co-creation and co-production are used in relation to wind energy development by focusing on how actors can come together across differences and create projects, processes, and services that are of more value and benefit to a wider set of actors. Co-creation is not yet widely applied in relation to wind energy, but in taking stock of the literature, we have attempted to create a foundation for future work. The review demonstrates that the literature employs co-creation in three different ways: first, to capture the formation of representations and identities in the context of wind energy development; second, to understand (potential) innovations in sociotechnical systems; and third, to account for a governance approach that promotes collaborative knowledge generation and decision-making.

Co-creation distinguishes itself from participation in important ways. The concept emphasizes the need for co-production of knowledge and social learning and points to alternative modes of organization with diverse actor positions in relation to wind energy development. Accordingly, actors represent particular interests and capacities and inhabit roles other than those of citizens or publics who are consulted on already-finalized plans or are engaged in deliberation and consensus-making. This calls for developing governance models that unveil the different interests at play (e.g., those of developers, neighbors, local politicians, landowners, social movements, and local businesses) and allow for the development of robust compromises between all these different and equally legitimate interests. The co-creation perspective also underlines that actors can participate in multiple and material ways by having competences, interests, and skills that enable them not only to co-create the planning agenda [16] but also co-create and improve technology designs through, for instance, making modifications to heat pumps or smart home equipment [103,104] and thus co-creating the sociotechnical system from the bottom up. We suggest that this might be key to unlocking the potential for increased value generation and collaborative wind energy development.

In considering what a co-creation perspective could add to energy policies or future research endeavors, we would like to offer a couple of suggestions. Participation through formally established spaces (e.g., those stipulated in planning regulations) is only one way of integrating alternative visions, perspectives, and competences into wind energy development. The creation of spaces for such alternative actor positions and the granting of permission for citizens to co-create the system actively constitute political tasks that necessitate a reconfiguration of the sociotechnical assemblage to include initiatives coming from below. An important precondition is to consider citizens not only as potential co-creators of knowledge, decisions, and governance structures but also as capable of adding to energy transitions in a more material manner.

Longitudinal studies of how bottom-up initiatives unfold could potentially provide insight into how and under what circumstances actor roles change over time and affect the trajectories of project development and sociotechnical systems as well as the ways in which we think about wind energy development and social innovation more generally. Moreover, understanding these forms of co-creation requires attention to the interrelations of actors, interests, practices, and institutions involved in the energy assemblage. This could occur through ethnographic fieldwork; participant observation; following the day-to-day practices of different actors engaged in setting up cooperatives and creating community energy projects or distributed energy systems; and tracing the continuous translations of rules, regulations, and technologies across space and time. Such research approaches might reveal how co-creation and innovation happens; if and when actors feel empowered and when they do not; and how projects and systems are co-produced in between values, visions, and the material affordances of technologies. Other approaches attentive to the same factors could entail action-research or future workshops that could also provide insight into how transformative engagements could be achieved by challenging the constitution of the space in which different actors meet. Moreover, because part of the literature explicitly links co-creation to social justice, it could also be relevant to further investigate if and how co-creation supports the pursuit of a socially just transition; some studies suggest that this is not necessarily the case [109].

It is crucial to move beyond dichotomous thinking in the forms of social acceptance versus opposition, experts versus laypeople, and technical versus social. Instead, we should give

sustained attention to all the interrelated, often contrasting elements that constitute energy transitions. As we wrote in the introduction, much literature on participation and social acceptance has had a tendency to separate participation—or the social—from these sociotechnical entanglements. While this literature has provided valuable insight into the reasons for local opposition toward specific wind farm developments, additional perspectives are needed to understand wind power controversies [102] or how publics, in their various forms, can become a value-adding element in wind energy development. The co-creation perspective can be a suitable tool for this task because it simultaneously attends to ontological questions about the entanglement of the social and the technical to understand how the world is as well as to normative considerations about what the world could and should be.

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