Review

Co-production in the wind energy sector: A systematic literature review of public engagement beyond invited stakeholder participation

Helena Solman [*], Mattijs Smits, Bas van Vliet, Simon Bush

Environmental Policy Chair Group, Wageningen University and Research, Hollandseweg 1, 6706 KN Wageningen, The Netherlands

ARTICLE INFO

ABSTRACT

Public concerns surrounding landscape conservation, noise pollution and impacts on bird populations are commonly incorporated into the planning phase of wind energy projects. However, public involvement tends to be highly localized and procedural, aimed at informing local stakeholders and gaining their acceptance for implementation. At the same time, other ways of engaging the public have emerged that move beyond invited stakeholder participation to facilitate the co-production of wind energy technologies and the landscapes in which they are placed. This paper systematically reviews the academic literature with the aim of identifying and characterizing these modes of co-production. A total of 230 papers published between 2009 and 2019 that report on public engagement with wind energy were included in our review. From this sample, we characterise public engagement into three modes of co-production: (1) local co-production, in spatially proximate wind energy projects; (2) collective co-production, performed through collaboration among different actors in the wind energy sector, joined ownership or consumption of wind energy; and (3) virtual co-production, mediated through information technology. These different modes of co-production cover a broad spectrum of ways in which local and non-local publics engage in decisions about where, when, how and by whom wind energy projects are designed, developed and managed over time. Combined, they can offer guidance for future research on how the wind energy sector can further support a transition to sustainable and inclusive energy systems.

1. Introduction

Offshore and onshore wind is an increasingly efficient and price-competitive renewable source of energy, contributing 16% of electricity produced globally by renewable sources of energy in 2016 [1]. In countries such as Denmark, wind energy has emerged as critically important energy infrastructure, and many other countries plan to increase their share in wind energy production in the coming decades [2]. However, plans for upscaling wind energy infrastructure are increasingly met with growing public opposition [3,4]. Such resistance tends to be voiced by local communities, local and non-local interest groups and also sparks debates at regional and national levels [5,6]. Central to this opposition are concerns over the visual, auditive and ecological impacts on landscapes [7–9], as well as concerns related to the reliability, safety and aesthetics of the wind turbine technology [10,11].

Growing opposition to wind energy indicates a clear need to assess the ways in which different publics are engaged in the design and development of wind energy systems [12–14]. To increase the involvement of the public in decisions on wind energy, public planning agencies have experimented with different forms of participation [e.g. [15–17]]. Emphasis has been particularly given to increasing the involvement of local communities in issues related to the design and location of specific wind energy projects [11,18,19] and more generally to participation in creation of local [20] and regional [21] energy strategies and plans. In most instances, these forms of public engagement fall under what is termed 'invited stakeholder participation' [22]. These, legislated procedures aimed at informing local stakeholders and gaining their acceptance for implementation of wind energy have so far predominated [23].

Although invited stakeholder participation can be successful, there are at least three limitations of selecting this approach as dominant way to govern public engagement with wind energy. First, the substantive involvement of stakeholders in the design of wind turbines and wind parks remains problematic because of the highly technical nature of industrial innovation [10] and project development [24]. Second, participatory forms of spatial planning tend to predefine who can participate, with a dominant focus on nearby residents to the exclusion of publics outside 'planning areas' [25]. Third, invited stakeholder

participation commonly focuses on public engagement during the planning stage [26] and not during the stages of technical design, implementation and ongoing operation of wind energy installations. As a result, public participation in the governance of wind energy has been largely symbolic [23,24,27] and has not accommodated societal debates over the form and function of wind energy in the wider energy transition.

Next to invited stakeholder participation in the (wind) energy sector, a more diverse set of ways to engage concerned publics is needed [26,28–33]. Notably, experiments in active and self-selected engagement by concerned publics have emerged with the aim of 'co-producing' plans, policies and public services related to wind energy [34,35]. Co-production involves means of public participation that include and go beyond invited stakeholder participation by opening up multiple ways through which different publics choose to engage with wind energy based on their concerns, needs and motivations [29,36]. Instead of focusing on how acceptance for wind energy can be gained through invited forms of participation, co-production focuses on how publics continually shape decisions related to wind energy. In doing so, co-production opens up an analytical approach for assessing the extent to which existing and emerging modes of public engagement can contribute to the democratisation of sustainability technologies [36].

Examples of co-production in the wind energy sector include cases in which wind parks are developed by energy cooperatives in ways that enable publics to invest and contribute to their design [37,38]. Similarly, web-based applications are increasingly used to collect public concerns related to the ongoing operation of wind turbines [39]. These examples go beyond invited stakeholder participation by opening up wind energy on both land and at sea to otherwise 'excluded' spatially distant publics [40]. But while there is also growing academic attention to these new kinds of public engagement that enable co-production [41], the wind energy literature remains very fragmented and no attempt has been made to review its current status.

We address this gap by undertaking a systematic review of literature focused on different forms of public engagement that include and go beyond invited stakeholder participation. We review academic articles from 2009 to 2019 focused on diverse forms of public engagement with wind energy and distinguish what modes of co-production exist and how they can be defined. In doing so we contribute to a broader understanding of how different publics engage with emergent technologies like wind energy to co-produce their materiality and their socio-spatial configuration over the full lifecycle of a wind turbine. Our results also contribute to calls for shifting research focus away from technological 'acceptance' [42] towards a more inclusive and dynamic processes of co-producing technologies and the landscapes in which they exist [34,36,43,44].

In the following section we provide a detailed explanation of the methodology used for our systematic literature review, followed by a presentation of our results. The final two sections of the paper discuss how the findings contribute to a broader understanding of co-production in the wind energy sector, and beyond, and identify areas for further research.

2. Methodology for a systematic literature review

Our systematic review is delimited to peer reviewed academic articles published between 2009 and 2019. This time period was selected after an initial examination of the literature suggested a substantial increase in papers focused on the role of public engagement in (wind) energy transitions after 2009.

Our systematic review methodology, following Haddaway et al. [45] and Pullin et al. [46], is based on a transparent protocol for searching and analysing the academic literature. This information is organised into four sequential steps following the Search, Appraisal, Synthesis, and Analysis (SALSA) Framework [47].

2.1. Step 1: Search - strategy

We limited our search to peer-reviewed academic articles published in English and discoverable in the subscription-based Scopus abstract and citation platform (using subscription of Wageningen University and Research Library). Scopus is deemed to be the most inclusive platform for systematic and repeatable literature searches [48] and, as such, suitable as a principal resource for systematic reviews [49]. In doing so we excluded other publication types such as book chapters, conference proceedings or grey literature. We further refined our search to the Scopus-defined disciplines of "social science" and "environmental science" – assuming these broad categories are most relevant to our target literature.

The search terms were defined using a combination of keywords related to public engagement and wind energy. For the purpose of transparency and reproducibility of our study, all the keywords are listed in the Table 1. The list of keywords was developed based on analytical frameworks and concepts developed by extant literature that theorises about participation from the perspective of co-production. We did this in four sub-steps.

First, following Chilvers et al. [30], we define the scope for the review by asking first order social scientific questions. We did this by linking keywords that describe materiality of wind energy infrastructure and landscapes (*what*), the actors or networks of publics engaging in decisions related to wind energy (*who*) and the ways in which they engage (*how*). Inspired by the work of Felt [26], we also explores what evidence there is of *when* (i.e. with what degree of time sensitivity) wind energy is co-produced.

Second, we listed keywords for identifying practices of engagement that reflect or go beyond conventional practices and timeframes of invited stakeholder participation. These keywords enabled the identification of literature focused on the ways in which different publics are engaged over the 'lifespan' of a wind turbine - from turbine design to ongoing management after installation. These key words included forms of engagement that can express both support as well as forms of resistance to wind energy [30,50,51].

Table 1
Keywords used for sampling the literature.

Focus	Main keywords
Actor/ networks of publics influencing decision-making process	Local Network
	Consumers network
	Non-local
	Collectives
	Citizens
	Community
	End-users
	User
	Residents
Active (and long-term) notions of participation, including practices of design	Public engagement
	Collaboration
	Cooperation
	Alliance
	Partnership
	Public opinion
	Collective engagement
	Cooperatives
	Co-production/ coproduction
	Co-design
	Co-creation
Private and everyday engagement	Local engagement
	Local involvement
	Local participation
	Proximity
	Private
	Financial participation
(New) technologies of participation	Smart devices
	Internet
	Virtual

Fourth, we completed our search terms with synonyms. Every keyword was used in a search with combinations of synonyms for wind energy (wind power, wind park, wind turbine, windmills, wind energy infrastructure).

Our final list keywords were translated into the following query string:

TITLE-ABS-KEY () AND DOCTYPE (ar) AND PUBYEAR > 2008 AND PUBYEAR < 2020 AND (LIMIT-TO (SUBJAREA , "Soci") OR LIMIT-TO (SUBJAREA , "Envi")) AND (LIMIT-TO (LANGUAGE , "English"))

For a paper to qualify for initial inclusion in the sample the search terms used in the query needed to appear in either title, abstract or keywords of an article. The initial result using search for each keyword combination in this query string yielded a total of 1650 papers.

2.2. Step 2: Appraisal - strategy for determining relevance and validity of final sample

A final selection of publications was made by appraising of their validity and relevance, inspired by the qualitative approach of Vicente-Sáez and Martínez-Fuentes [52]. Publications that did not meet the following four 'relevance' criteria developed by the team of authors were excluded: (1) papers had to have a predominant focus on wind energy, (2) papers had to have a social scientific focus on wind energy (3) papers had to have an explicit focus on public engagement and (4) papers had to be available for download via university library subscriptions, open access, contacting the authors or by direct purchase. Applying these criteria led to exclusion of 1420 papers and yielded a final set of 230 papers (all of which are listed in the supplementary material file).

2.3. Step 3: Synthesis - strategy for retrieving data

The review was synthesised by systematically coding all papers in the final sample using Atlas.ti software. The content of sampled papers was parsed using a pre-defined set of codes which was developed based on the criteria of co-production outlined in the step of search strategy. That is, papers were coded for spatial aspects and the materiality of wind energy projects that are co-produced, actors involved, the extent to which publics influence design of wind energy technologies and landscapes, and the stages at which publics are involved (see Table S1). We then complemented the list with new codes that emerged from the literature. Finally, we grouped the codes into categories based on their relations. This enabled our characterisation of co-production in the next step of analysis.

2.4. Step 4: Analysis - strategy for making sense of the data

Finally, the papers were analysed by grouping all the coded papers based on their content in relation to insights about public engagement with wind energy. This was done by drawing on the list of codes that coalesced around three themes of co-production: local, collective and virtual. As these themes were mentioned to various extents across the papers, we grouped the papers based on their relevance and focus on co-production. Our framework is interpretive (inspired by Dixon-Woods et al., [53]) meaning that we organised and qualitatively synthesized the literature in a way that helped to answer our research question. Researchers asking different research questions might propose other way of ordering these papers - including more quantitative approaches to synthesis.

3. Results: modes of co-production

As expected, the papers reviewed distinguish a variety of ways in which public engagement has moved beyond invited stakeholder participation that highlight extant and novel forms of wind energy co-production. The review demonstrates a spread of ways in which

publics are engaged and contribute to the co-production of wind energy across three stages of wind energy projects: (1) design, (2) planning and (3) operational management. Furthermore, the literature documents different forms of co-production across these stages of wind energy projects and is focused on the key concerns related to the procedural justice and the materiality of wind energy technologies and their positioning in landscapes.

Out of the 230 papers reviewed three clusters of papers emerge, representing three distinct modes of co-production. The distribution of sampled papers among the clusters and within their sub-clusters is visualised by the graphs in the Fig. 1.

The first cluster, representing 69% of all papers sampled, is made up of papers that shed light on the nature of public engagement with wind energy exclusively in a local context. In this literature, the demarcation of locality is an important determinant of who can engage and how, which is why we label this cluster 'local modes of co-production'. Within this cluster multiple ways in which different local actors co-produce wind energy projects are reported on.

The papers covering local modes of co-production define local publics as local stakeholders including farmers, landowners, indigenous communities or residents in urban or residential areas. Amongst the papers included in the cluster of local modes of co-production, there is a clear line of literature focusing on invited stakeholder participation in local, onshore wind energy projects. We then identify a cluster of papers documenting a range of alternative forms of local co-production in onshore wind energy projects and a cluster of literature devoted to public engagement with offshore wind energy. Another sub-set of papers focuses on public engagement with implemented wind energy projects and reports on how publics engage with wind turbines after their implementation and until decommissioning. We also grouped together a small cluster of papers describing how local wind energy projects include engagement of actors who do not live in the area permanently, including tourists and second-home owners. Lastly, there is a set of papers documenting cases of and reasons for locally organised resistance to wind energy.

The second cluster covering collective modes of co-production consists of papers that document the networked-like relationships among involved actors. In contrast to the first cluster, this smaller cluster of papers, accounting for 17% of all papers sampled, focuses on the organisation of collective, beyond-local public engagement. Within this cluster of literature, we identify a sub-set of papers focusing on public engagement organised through investment collectives, such as wind energy cooperatives. Next to that, we found that there is another group of literature focusing on how public engagement can be integrated in collaborative networks of the wind energy sector, in which publics form partnerships and alliances or participate in open research and innovation. A final sub-set of papers document networked forms of collective resistance that transcend the local scale.

Finally, the third cluster of virtual modes co-production represents 10% of the final sample and it covers digital and online forms of public engagement. These papers describe a spectrum of online or virtualreality-based ways of engaging both local and non-local publics in a diverse set of issues around wind energy. One subset of papers in this cluster focuses on how publics become involved in wind energy projects through digital wind energy markets (including online forms of financing and investment). A second subset of paper focuses on techniques for enabling public engagement with wind energy infrastructure through different digital visualisation techniques (e.g. GIS visualisation, virtual reality). Whereas these forms of virtual co-production most commonly explore supportive or neutral forms of engagement to wind energy, a final sub-set of papers did report on virtual forms of resistance.

While distinct, these three clusters of papers are not mutually exclusive. For instance, one set of papers discussed 'community wind energy' (representing 4% of all papers sampled), which covers both local and collective means of public engagement. We also found that while 'community wind energy' could represent a mode of co-production of its
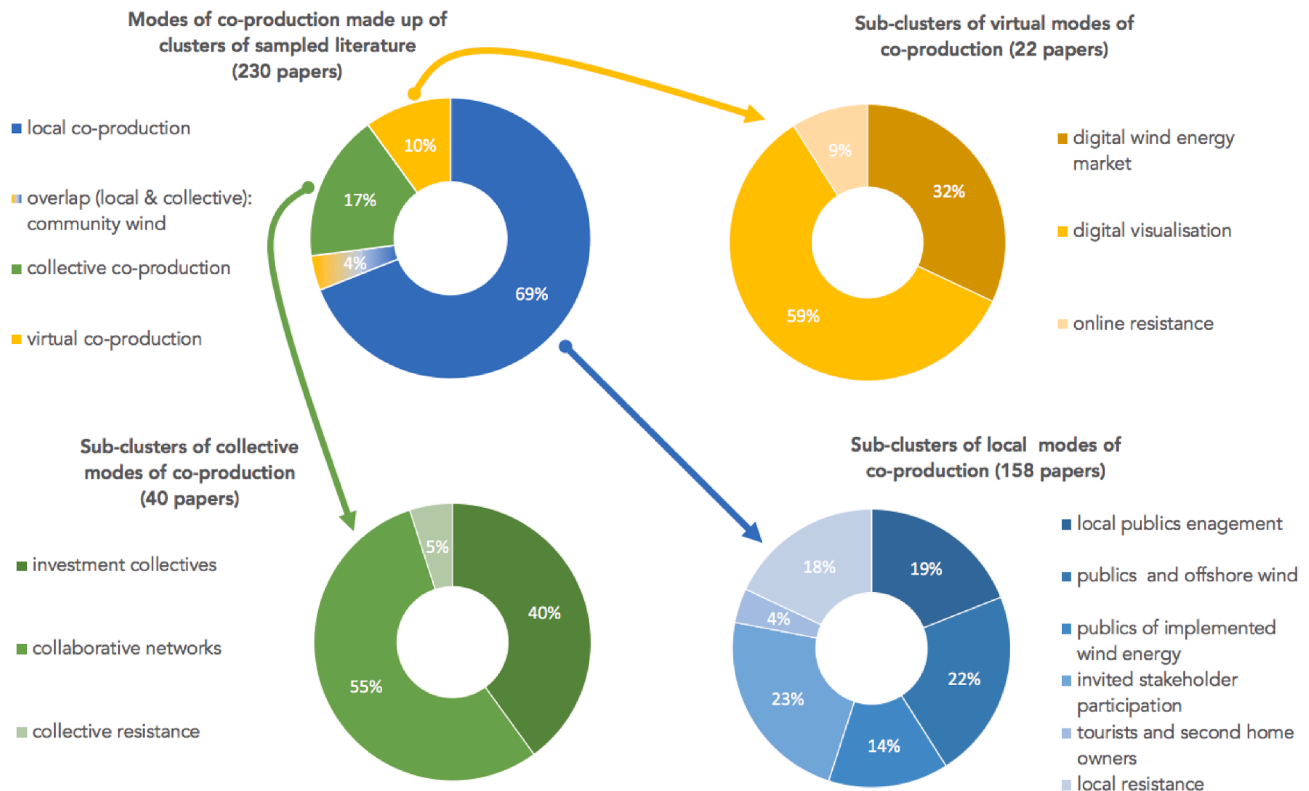
Fig. 1. Clusters and sub-clusters of sampled literature.

own, there seems to be a lack of coherence in these papers on the definition of a 'community' – the term is used to describe both 'local groups' and 'communities of interest'.

In the next sections, we present the qualitative results of the review in terms of the state of knowledge about each of the modes of co-production, as presented in the clusters of papers.

4. Local modes of co-production

Local modes of co-production are represented as a set of ways in which local publics are engaged with spatially-proximate wind energy projects [54–56]. This cluster of papers explores the ways in which local publics invest in wind energy on their land [e.g. [57]] or take an active or leading role in planning and managing spatially proximate wind energy projects [55], both onshore and offshore [40,58]. Most of the papers reviewed focus on micro-scale projects in remote areas [59], on-farm wind energy projects [57], and urban or semi-urban projects [60]. The review shows that whereas invited stakeholder participation at local level often focuses on gaining acceptance from local stakeholders for implementing pre-existing wind energy plans [61], all together, local modes of co-production tend to focus on active and self-selected engagement of local publics [62]. Local modes of co-production also tend to enable local publics to remain engaged across the lifetime of the wind energy projects [63,64].

Within this literature, being landowner or a resident of an area is commonly seen as a defining determinant of (1) who these local publics are, (2) their degree of involvement in the development and management of wind energy projects [65,66], and (3) how benefits are distributed [60,67]. The degree of influence on and benefit from wind energy production is seen in direct relationship to either the shareholdings of individuals [68,69] or their proximity to operational wind parks [70].

Within the literature on local modes of co-production, there are however alternative perspectives on how to define local publics. As a

whole, literature on local modes of co-production does not treat local publics as a predefined set of actors. Instead, local co-production appears to focus on constellations of local actors that coevolve with agendas linked to wind energy, such as electrification [59], economic benefits [71] or transitioning local areas towards renewable energy [72]. Even though some papers define local publics as homogeneous entities [73,74], there is also recognition that within each community of place differences are found in terms of opinions and attitudes towards wind energy [75]. Indeed, literature on local modes of production moves beyond homogenising treatment of local publics by unpacking resistance as a complex and gradually evolving response to wind energy that goes beyond public opinion as for or against wind energy [e.g. [76]] to include a degree of support or resistance [77] and how it changes over time [78]. Some of these papers demonstrate that space for resistance and contestation is in fact a central part of the co-production process and that diversity in opinions, needs and practices is intrinsic to any local wind energy development [79,80].

In contrast to invited stakeholder participation, which tends to predefine the issues around local wind energy projects [81], all the different local modes of co-production together include a diverse set of bottom-up motivations of local actors involved with wind energy [82–84]. Environmental motivations are reported as the most common reasons for individuals or local communities concerned about energy transition or climate change to favour wind energy developments [85]. However, environmental concerns also extend to the impacts of wind turbines on local landscapes and nature [86]. Finally, motivations for getting involved in local wind energy projects can be purely financial, indicating that support for wind energy does not imply opposition to fossil fuel-based energy sources [87].

The papers reviewed collectively highlight two overarching debates of moving beyond invited stakeholder participation and exploring the potential for co-production as including more diverse set of open and responsive modes of public engagement.

First, delegating decision-making power on local energy provision to

local publics is reported as a way of democratising the design, implementation and/or use of energy infrastructure [56]. Building on this idea, several papers focus on the consequences of including local knowledge and expertise in the design of wind energy projects. For example, Baker [88] and Jami and Walsh [89] emphasise the value of local (and indigenous) knowledge in improving the decisions over if, where and how wind energy projects should be developed at the local scale. They argue that local wind energy projects require an early stage and open process of participation that allows for experimentation with renewable energy technologies, incorporation of broader sustainability agendas and self-governance. Similarly, Chezel and Labussière [62] argue that locally managed wind energy projects can optimise the use of local capital, landscape and local knowledge which in turn increases the sense of justice of these projects and the probability of their positive effects on local communities. In spite of the perceived benefits of engaging local publics at the stage of design , only a few studies were found that outline processes for and benefits of engaging local publics in the work of wind turbine manufacturers [82,90]. However, we did find examples of synergies between local modes of co-production and work of landscape architects [91,92] and spatial planners [93,94]. These studies propose novel methods of planning and envisioning local wind energy landscapes in an open process of co-design and integration of economic sectors (e.g. tourism, recreation and fishing) with wind energy.

Second, engaging local publics is seen as a means of enabling political action related to, but extending beyond, direct concerns of wind energy projects in regional and/or national public debate [95]. For example, Delicado et al. [96] explores the complexities of setting regional or national goals around wind energy while creating space for locally self-determined planning. Others respond to this challenge by arguing that decisions on large-scale wind energy need to engage local publics [14], but highlight the difficulties of doing this across all land and seascapes. Devine-Wright [95], for instance, demonstrate that it is difficult to define local publics in offshore wind energy projects given these projects represent substantial national investments and transcend the local scale. Nevertheless, the literature presents abundant evidence that offshore wind energy projects raise similar kinds of public concerns as onshore wind energy [97,98] and, as such, require equal attention to engaging local publics in their co-production [99–102].

5. Collective modes of energy co-production

The cluster of papers representing collective modes of co-production focus on all forms of collaboration in both single and multiple wind energy projects, as well as issue-oriented networks established for collaboration within the wind energy sector. The papers reviewed reveal collective modes of co-production that purposively seek out spatially dispersed publics who hold concern over and self-define as participants in decisions relating to the development of wind energy [103–105].

Collective publics tend to be broadly defined as formalised networks of societal actors that include, but are not limited to, voluntary and often self-organised collectives [e.g. [103,104]], partnerships and networks of collaboration [e. g. [82,106,107]], also including networks lobbying against wind energy [108,109]. The composition of these networks is mostly not dependent on a given spatial category, such as local, regional or national, but instead links publics who share common goals and concerns related to wind energy. These networked 'communities of interest', have a broader scope than the local 'communities of place' [103,110], as they can bring together dispersed actors into contact and dialogue over the design and operation of wind energy.

Two distinct types of practices of co-production by collective publics emerge from this cluster of papers, both focused on the concerns and aspirations of collective publics linked to wind energy technology and the embedding of these technologies in landscapes.

First, collective co-production is demonstrated through financial participation, found in literature on energy cooperatives [103,104] and

community-owned wind energy projects [65,68,69,111]. A common finding of this literature is that such co-production is based on a collective ownership model for wind turbines which in turn distributes energy back to its members and/or provide financial benefits to the investors. Wind energy collectives tend to involve collective publics as investors who in turn receive the right to financial benefits or energy produced- individually [103] or as a community [65]. Seed funding might be sought from members enrolling in the scheme at early stage who then receive future rights to financial benefits [112] or to the energy that is produced from the turbines when operational. Wind energy collectives are seen as a promising model for developing wind energy projects given their ability to overcome financing constraints and also to generate support at local level by taking a more tailor-made approach to project development and by involving users and local communities over time [113]. Warren and McFadyen [69], demonstrate how collective (financial) ownership of wind turbines can even translate into affirmative attitudes by collective public, expressed by for instance naming wind turbines.

Second, the involvement of collective publics also extends to engagement with wind turbines and their management across different stages of wind energy development. Collective publics in wind energy have been shown to seek involvement in decisions concerning operation of wind farms, including their ongoing management and maintenance [114], and even decommissioning and repowering wind energy installations [115,116]. Karnøe and Garud [82] and Tanner [90] for instance, show that close collaboration between early users of wind turbines and wind turbine manufactures in the Danish wind energy sector was an important step in finetuning subsequent designs. In this Danish case, collective publics were defined as users of wind turbines who contributed to 'wind meetings', organised to foster collective learning and feedback to the design process [82]. Despite being one of few examples of its kind, this case demonstrates that collective co-production can not only lead to better design but also foster positive engagement of collective publics in the wind energy sector at large.

This literature extends the notion of co-production by pointing to the role of networked collaboration between collective publics with professional actors, such as developers, energy providers and governments in initiating, developing and maintaining wind energy projects over time [117]. Collective co-production can, in this sense, materialise in private–public partnerships focused on joined development of wind energy projects [106,118] or in cooperation focused on improving assessments and evaluation of wind energy projects and their impacts [107]. The literature also points to how experts relate to publics and how their understanding of public concerns influences the process of technology innovation for the wind energy sector. Nevertheless, while there is evidence that collective co-production can enable effective cooperation between publics and experts, there are very few such examples in the literature [e.g. [119]].

A common assumption in the literature on collective co-production is that the input provided by collective publics is likely to be reached through deliberation [66,120]. It is furthermore assumed that the more inclusive these networks are the more deliberation they can foster and the greater the likelihood that technical and landscape related decisions will be seen as legitimate by the publics involved [120]. However, our review also reveals there has been limited analysis of the inclusion or exclusion of different opinions within these networked collective publics. There is also limited evidence within literature on wind energy collectives on how deliberation feeds into different stages of wind energy development, and where deliberation is documented, the content of debates appears largely limited to financial and technical efficiency.

6. Virtual modes of co-production

Virtual modes of co-production in wind energy are observed in the literature as a set of practices of engagement with wind energy projects mediated by information technology, which connects people located

across any distance from wind energy projects into digitally-networked publics [112,121–124]. Such engagement is linked to the emergence of online platforms, websites and apps that mediate public involvement in wind energy projects and to the proliferation of visualization and geospatial tools for public engagement in the wind energy planning [125].

The papers reviewed in this cluster all demonstrate that virtual co-production significantly breaks down spatial, temporal or social restrictions to public engagement. Virtual modes of co-production are, as such, seen as an efficient means through which public concern materialise [126] and are communicated online [127] across different stages of wind energy projects. For instance, the emergence of websites, platforms and social media groups devoted to wind energy, are reported to enable large numbers of people to express interest in supporting and financing [112], or indeed resisting [80], wind energy projects long before they are developed. At such an early stage virtual co-production can take a form of an online crowdfunding initiative that searches for investors among broader publics who are willing to provide funding for wind energy [112]. For instance, a USA-based study reported on an online crowdfunding initiative that enabled residents of a whole state to participate in financing of a large wind energy project [112]. Little evidence was found, however, on how investors living far away from wind energy projects relate to them and interact with the online means of engagement across the projects' lifetime.

There is also evidence on the motivations of publics to digitally engage with wind energy projects. A study of Gamel et al., [123], found that people concerned about the environment in Germany are "more likely to invest in wind energy and even seem to accept financial disadvantages for such 'environmentally-friendly' projects" [[123], p. 29]. However, it remains unclear how choices of these publics reflect their concern and preferences over where and how wind energy projects are developed. Here the reviewed literature that touches upon the issue of location, while limited, is split. For instance, Brady and Monani [124] show that remote and marketed as sustainable wind energy projects tend to appeal to digitally-networked publics who are interested in buying carbon offsets form such projects. In contrast, Gamel et al. [123], find that digitally-networked publics prefer making investments within their own region (radius 30 km) or neighbourhood (radius 5 km) as opposed to investments in foreign wind energy markets.

While this literature draws on the potential of virtual engagement for generating broader networks of support for wind energy projects, we also found evidence for that opening up wind energy projects to dispersed publics can lead to conflicts. For example, resistance was observed in case of wind energy projects developed in Ireland for export of green energy to the UK [128]. In this study, the authors found that "whilst local residents would bear the brunt of the external costs, most of the benefits would not be felt in Ireland (…) but instead be distributed further afield to wind farm operators, private corporations and their distant shareholders" [128]. As such, virtual modes of co-production that involve dispersed consumption and production of wind energy can lead to the emergence of new concerns about how costs and benefits are distributed.

Finally, the literature shows that virtual modes of co-production enable novel ways of engaging with digitalised versions of wind energy technologies and landscapes. Increasingly common are visualisation and geospatial tools that simulate the possible outcomes of different decisions about wind energy designs [125,126,129]. The premise of virtual modes of co-production that engage publics with digital representations of wind turbines or wind parks is that such engagement can foster high levels of public influence over how and where wind energy should be developed [130,131]. For example, web-based visualisation tools are proposed as channels of effective communication between the publics and experts to discuss concerns and alternative wind energy designs [129]. Additionally, we found studies reporting on that energy suppliers and researchers working on wind turbine innovation are also using virtual reality to engage publics to estimate noise impacts of new wind turbines [132,133] and evaluate

how wind energy projects might be integrated in areas of cultural heritage [134].

But while the potential of engaging dispersed, digitally-networked publics is a key feature of the papers reviewed, evidence of co-producing wind energy in such ways remains very limited. The characteristics of those publics most likely to engage with virtual technologies or the extent to which these publics contribute to decisions on the design, implementation and management of wind energy projects also remains unclear. The current literature most likely does not provide a complete overview of the full spectrum of possibilities for virtual co-production of wind energy technologies and landscapes. There is also little published information on the roles of the actors developing these online services and mediating interaction with wind energy; especially in terms of their influence on opening or closing down the decisions of digitally-networked publics that affect wind energy projects across the different stages of wind energy development.

7. Discussion

Our review distinguishes between different modes of co-production in the literature on public engagement with wind energy. The identified local, collective and virtual modes of co-production are an attempt to represent the diversity of ways in which different types of publics engage with and shape the materiality of wind energy technology and their placement in landscapes over time. In contrast to the dominant approach of invited stakeholder participation, these three modes of co-production together open up at least five ways of understanding how diverse publics can contribute to the design, planning and ongoing management of wind energy (Fig. 2).

First, local, collective and virtual modes of co-production, all appear to enable both local and spatially-dispersed, 'non-local' publics to engage with wind energy. Whereas a local mode of co-production relies on a specific geographic or administrative area to determine who has the right to be involved and how [65], collective and virtual co-production enable the emergence of spatially dispersed publics to form networks by sharing a common interest in wind energy [103,104]. This means that instead of proximity alone, different publics emerge depending on the concerns and needs [135] that motivate them to become actively involved in wind energy projects. By opening up to co-production and hence to non-local publics, which generally get less attention as actors in governance of energy systems [25], different modes of co-production can enable multiple concerns and values to be expressed and translated into the design, implementation and management of wind energy projects.

Second, local, collective and virtual modes of co-production enable a dynamic understanding of concerned publics, in contrast to static and idealised publics of invited stakeholder participation. Each of the modes of co-production views publics as plural and consisting of dynamic constellations of actors that coalesce and disband around wind energy over time [see for e.g. [29]]. Understanding publics in this way underscores the value of moving from energy 'planning' to energy co-production. That is, a shift from predetermining publics and their concerns and values [22,44] in the planning phase of a wind energy project to continually engaging the concerns and values of diverse publics across the entire life span of a project [97]. In doing so co-production, when seen across the various modes elaborated in this review, can enable the continual emergence of publics to define the agenda around wind energy developments, where they should be and what concerns should be addressed.

Third, the review demonstrates the importance of understanding the reasons *why* different publics may choose to engage through different modes of co-production. We found that the motivation to be engaged in the wind energy sector is not always linked, as is commonly assumed, to 'green' political values [87]. The review instead indicates that different publics engage in the co-production of wind energy for reasons that may go beyond environmental concerns alone. For instance, a degree of
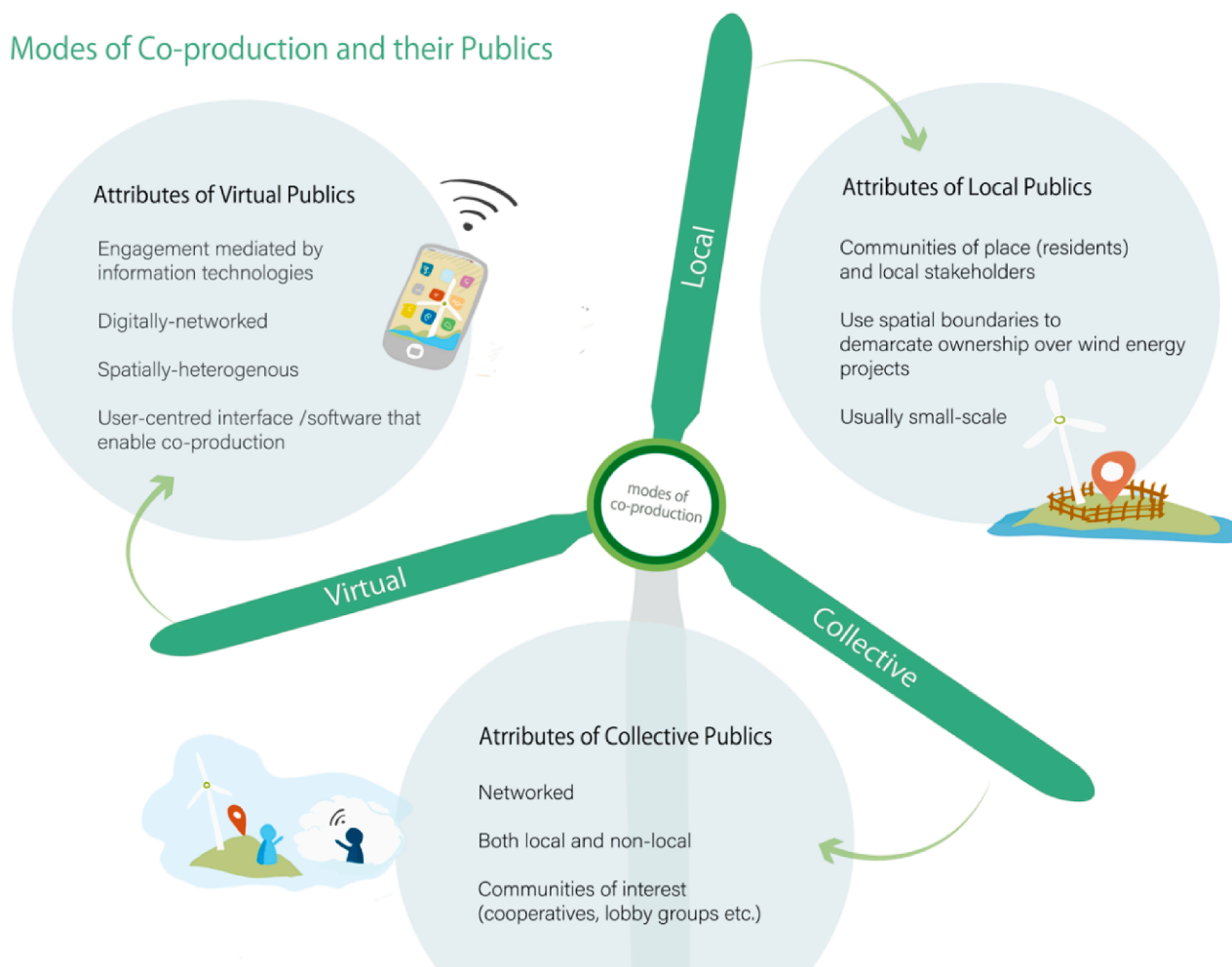
Modes of Co-production and their Publics

Attributes of Virtual Publics

Engagement mediated by information technologies

Digitally-networked

Spatially-heterogenous

User-centred interface /software that enable co-production

Attributes of Local Publics

Communities of place (residents) and local stakeholders

Use spatial boundaries to demarcate ownership over wind energy projects

Usually small-scale

Local

Virtual

Collective

modes of co-production

Atrributes of Collective Publics

Networked

Both local and non-local

Communities of interest (cooperatives, lobby groups etc.)

Fig. 2. Co-production modes and their publics.

support or opposition to wind energy appears to be based on a mix of financial (dis)benefits [87,114,136], demand for local (or national) renewable energy [137] in addition or in combination with green political values. How each mode of co-production can draw on these different motivations to increase the input from the publics on design, planning and long-term management of wind energy technologies and landscapes, either individually or in combination, however, remains less clear and should be the subject of further research.

Fourth, our review indicates that by engaging publics at different spatial scales co-production may be able to overcome some of the prevailing concerns associated with wind energy landscapes and technology (especially around noise and landscape pollution) [126,132]. In contrast to invited stakeholder participation, a co-production perspective focuses on opening up to, not only compensating for, concerns in the hope of finding novel solutions to issues 'saturated' (at least in part) by the predefinition of publics and their concerns [22,65]. By breaking down these predefined publics and concerns, modes of co-production can enable new forms of 'energy citizenship' [31], whereby the publics take responsibility for long-term management of wind turbines and embrace both positive and negative aspects of wind turbine developments and co-decide on how benefits and costs associated with wind energy should be distributed. Nevertheless, different modes of co-production also appear to enable the emergence of new concerns around wind energy (e.g. around perceived justice of online investments in remote wind energy projects [25,123]. Much of this literature reviewed is, however, only indicative of the emerging concerns and issues rather than providing examples of good practices for conflict resolution.

Overall, there is space for further research on the extent to which different modes of co-production can internalise these concerns and contribute to conflict resolution in different empirical settings.

Finally, the review indicates that the modes of co-production enable a more flexible understanding of what wind energy technology (and infrastructure) entails and how it can be configured in landscapes [82,84,120]. By fostering such an understanding of flexibility in design and management within diverse publics many of the concerns held over wind energy projects can be mitigated [82]. But while the review shows that publics can play a role in decisions about wind turbine technology, including how different wind turbine models are designed, operated and maintained, empirical examples of such engagement remain limited [except e.g. [82]]. There is more evidence of local and collective modes of co-production enabling publics to influence decisions about where and how wind energy is developed [e.g. [138]]. Virtual co-production is recognised in some papers as holding promise for interactive visualisation of design principles [125,126]. However, it is apparent that further empirical research is needed to understand the ways in which these technologies (visualisation software, apps or platforms) are used in practice (for example as already done for smart meters [51]).

These five ways of understanding how diverse and emerging publics can contribute to the design, planning and ongoing management of wind energy demonstrate that these three modes of co-production are not mutual exclusive. They instead can co-exist, enabling different publics to influence different material aspects of wind energy systems, related to technology and landscape, across the stages of wind energy development. Not only does this once again contrast with the dominant

approach that focuses only on invited forms of stakeholder participation [26,32], it also opens up the potential for enabling (dynamic and dispersed) publics to have long-term influence over wind energy projects [84,137], even up until they are decommissioned [139].

Realising any form of synergy between these forms of co-production, however, also requires recognising their clear differences and (potential) contradictions. Collective and virtual modes of co-production are more focused on the engagement of networked, non-local publics across the different stages [e.g. [112,123]]. But in doing so they do tend to focus on stages of development that match the needs or aims of project developers – for example financing [112]. Furthermore, local and collective modes of co-production appear to be more dominant at the stage of planning and ongoing management, whereas virtual modes of co-production were more often found at the early stage of planning. It is also evident that there is overall little attention to the stage of design – perpetuating the black-boxed nature of wind turbines (as also found to in case of other technologies [33]). However, to understand how these different modes of co-production can have synergistic effects across the full lifespan of wind energy projects more research appears necessary; especially as ambitions shift to developing carbon–neutral energy systems in many regions of the world.

8. Conclusion

The current literature reveals three modes of co-production that demonstrate the multiple ways in which local and non-local publics can influence the design, implementation and ongoing management of wind energy. These modes of co-production enable these publics to express concerns about both wind technologies and the location of wind energy in landscapes at relevant stages of wind energy projects. This review shows how these modes of co-production offer an approach to public engagement that goes beyond invited stakeholder participation which has so far dominated in the wind energy sector and tends to focus on the concerns of local publics and landscape planning alone.

The three modes of co-production have not received the same amount of attention in the literature. Local and collective modes of co-production have been the focus of more academic research than virtual modes of co-production. It is likely, however, that virtual co-production will continue to expand in practice as energy companies and governments seek to increase online involvement of publics in the design and management of wind energy projects. The value of virtual co-production may become even more important as wind energy projects are located in distant landscapes, for instance at sea, and as a means of linking to other smart technologies employed in the everyday lives of energy consumers.

Further research is needed to unravel the degree to which all three modes of co-production influence the sustainability of wind energy infrastructure in practice, taking both different stages of wind energy development as well as their interaction with landscapes and technologies into account. Empirical research is needed to improve the understanding of how each mode enables different publics to become engaged and with what consequences for existing and future wind energy configurations. Finally, research is also needed on the interaction between local, collective and virtual modes of co-production, to assess whether and how they are complimentary in shaping the role of wind energy in the wider energy transition.

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.

Acknowledgements

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.erss.2020.101876.

References

[1] International Renewable Energy Agency. Wind energy. 2019 [cited 2020; Available from: https://www.irena.org/wind.

[2] Wind Europe. National Energy & Climate Plans. 2020 [cited November 2020]; Available from: https://windeurope.org/2030plans/.

[3] M. Wolsink, Wind power implementation: the nature of public attitudes: equity and fairness instead of 'backyard motives', Renew. Sustain. Energy Rev. 11 (6) (2007) 1188–1207.

[4] A. Nadaï, D. van der Horst, Wind Power Planning, Landscapes and Publics, Elsevier, 2010.

[5] R.F. Hirsh, B.K. Sovacool, Wind turbines and invisible technology: unarticulated reasons for local opposition to wind energy, Technol. Culture 54 (4) (2013) 705–734.

[6] M.J. Pasqualetti, Opposing wind energy landscapes: a search for common cause, Ann. Assoc. Am. Geogr. 101 (4) (2011) 907–917.

[7] M. Karydis, Public attitudes and environmental impacts of wind farms: a review, Global Nest J. 15 (4) (2013) 585–604.

[8] A. Nadaï, O. Labussière, Birds, wind and the making of wind power landscapes in Aude, Southern France, Landscape Res. 35 (2) (2010) 209–233.

[9] K. Dai, A. Bergot, C. Liang, W.-N. Xiang, Z. Huang, Environmental issues associated with wind energy – a review, Renewable Energy 75 (2015) 911–921.

[10] R. Künneke, D.C. Mehos, R. Hillerbrand, K. Hemmes, Understanding values embedded in offshore wind energy systems: toward a purposeful institutional and technological design, Environ. Sci. Policy 53 (2015) 118–129.

[11] I. Oosterlaken, Applying value sensitive design (VSD) to wind turbines and wind parks: an exploration, Sci. Eng. Ethics 21 (2) (2015) 359–379.

[12] J. Kirch Kirkegaard et al., Paradigm shift in Danish wind power: the (un) sustainable transformation of a sector. Journal of Environmental Policy & Planning, 2020: p. 1-17.

[13] N. Pidgeon, C. Demski, C. Butler, K. Parkhill, A. Spence, Creating a national citizen engagement process for energy policy, Proc. Natl. Acad. Sci. 111 (Supplement_4) (2014) 13606–13613.

[14] Y. Rydin, M. Lee, S.J. Lock, Public engagement in decision-making on major wind energy projects, J. Environ. Law 27 (1) (2015) 139–150.

[15] A.A. Jami, P.R. Walsh, Wind power deployment: The role of public participation in the decision-making process in Ontario, Canada. Sustainability (Switzerland), 2016. 8(8).

[16] R. Janssen, G. Arciniegas, K.A. Alexander, Decision support tools for collaborative marine spatial planning: identifying potential sites for tidal energy devices around the Mull of Kintyre, Scotland, J. Environ. Plann. Manage. 58 (4) (2015) 719–737.

[17] S. Stremke, P. Picchi, Co-designing energy landscapes: application of participatory mapping and, in Handbook on the Geographies of Energy. 2017, Edward Elgar Publishing.

[18] G.B. Jerpåsen, K.C. Larsen, Visual impact of wind farms on cultural heritage: a Norwegian case study, Environ. Impact Assess. Rev. 31 (3) (2011) 206–215.

[19] E. Nordman, D. O'Keefe, E. Arndt, Enhancing public engagement on offshore wind energy using "Genius loci": A case study from the Lake Michigan Coast, Int. J. Sustain. Policy Practice 12 (4) (2016) 19–32.

[20] S. Gustafsson, J. Ivner, J. Palm, Management and stakeholder participation in local strategic energy planning – examples from Sweden, J. Cleaner Prod. 98 (2015) 205–212.

[21] B. Igliński, et al., SWOT analysis of the renewable energy sector in Poland. Case study of Wielkopolskie region, J. Power Technol. 95 (2) (2015).

[22] E. Cuppen, The value of social conflicts. Critiquing invited participation in energy projects, Energy Res. Social Sci. 38 (2018) 28–32, https://doi.org/10.1016/j.erss.2018.01.016.

[23] M. Wolsink, Planning of renewables schemes: deliberative and fair decision-making on landscape issues instead of reproachful accusations of non-cooperation, Energy Policy 35 (5) (2007) 2692–2704.

[24] M. Wolsink, Near-shore wind power—protected seascapes, environmentalists' attitudes, and the technocratic planning perspective, Land Use Policy 27 (2) (2010) 195–203.

[25] U. Pesch, Elusive publics in energy projects: the politics of localness and energy democracy, Energy Res. Social Sci. 56 (2019) 101225.

[26] U. Felt. The temporal choreographies of participation: Thinking innovation and society from a time-sensitive perspective. Remaking participation: Science, environment and emergent publics, 2016: p. 178-198.

[27] G. Ellis, et al., Wind Power: Is There A "Planning Problem"? Expanding Wind Power: A problem of planning, or of perception? The problems of planning—a developer's perspective wind farms: more respectful and open debate needed, not

less planning: problem "Carrier" or Problem "Source"? "Innovative" wind power planning, Planning Theory Practice 10 (4) (2009) 521–547.

[28] I. Papazu, Participatory innovation: Storying the renewable energy island Samsø, Department of Political Science, University of Copenhagen, 2016.

[29] J. Chilvers, N. Longhurst, Participation in Transition(s): reconceiving public engagements in energy transitions as co-produced, emergent and diverse, J. Environ. Policy Planning 18 (5) (2016) 585–607.

[30] J. Chilvers, H. Pallett, T. Hargreaves, Ecologies of participation in socio-technical change: the case of energy system transitions, Energy Res. Social Sci. 42 (2018) 199–210.

[31] M. Ryghaug, T.M. Skjølsvold, S. Heidenreich, Creating energy citizenship through material participation, Soc. Stud. Sci. 48 (2) (2018) 283–303.

[32] N. Marres, Material participation: Technology, the environment and everyday publics. 2016: Springer.

[33] B. Wynne, Public participation in science and technology: performing and obscuring a political–conceptual category mistake, East Asian Sci., Technol. Soc. 1 (1) (2007) 99–110.

[34] L. Albrechts, Reframing strategic spatial planning by using a coproduction perspective, Planning Theory 12 (1) (2013) 46–63, https://doi.org/10.1177/1473095212452722.

[35] F. Corsini, C. Certomà, M. Dyer, M. Frey, Participatory energy: Research, imaginaries and practices on people' contribute to energy systems in the smart city, Technol. Forecast. Soc. Change 142 (2019) 322–332.

[36] J. Chilvers, M. Kearnes, Remaking participation in science and democracy, Sci. Technol. Human Values 45 (3) (2020) 347–380.

[37] A. Schreuer, D. Weismeier-Sammer. Energy cooperatives and local ownership in the field of renewable energy technologies: A literature review. 2010.

[38] J.A.M. Hufen, J.F.M. Koppenjan, Local renewable energy cooperatives: revolution in disguise? Energy Sustain. Soc. 5 (1) (2015).

[39] H. Hofstra. Windturbines stilzetten met een app op je telfoon. 2019 [cited 2020 March]; Available from: https://www.oneworld.nl/lezen/schone-energie/wi ndturbines-stilzetten-met-een-app-op-je-telefoon/.

[40] D.M. Hall, E.D. Lazarus, Deep waters: Lessons from community meetings about offshore wind resource development in the U.S. Marine Policy 57 (2015) 9–17.

[41] M. Wolsink, Co-production in distributed generation: renewable energy and creating space for fitting infrastructure within landscapes, Landscape Res. 43 (4) (2018) 542–561.

[42] P. Devine-Wright, Beyond NIMBYism: towards an integrated framework for understanding public perceptions of wind energy, Wind Energy 8 (2) (2005) 125–139.

[43] S. Jasanoff, S.-H. Kim, Sociotechnical imaginaries and national energy policies, Sci. Culture 22 (2) (2013) 189–196.

[44] B. Taebi, A. Correljé, E. Cuppen, M. Dignum, U. Pesch, Responsible innovation as an endorsement of public values: the need for interdisciplinary research, J. Responsible Innov. 1 (1) (2014) 118–124.

[45] N.R. Haddaway, P. Woodcock, B. Macura, A. Collins, Making literature reviews more reliable through application of lessons from systematic reviews: making Literature Reviews More Reliable, Conserv. Biol. 29 (6) (2015) 1596–1605.

[46] Collaboration for Environmental Evidence. Guidelines and Standards for Evidence synthesis in Environmental Management. Version 5.0 (AS Pullin, GK Frampton, B Livoreil & G Petrokofsky, Eds). 2018; Available from: www.environ mentalevidence.org/information-for-authors.

[47] M. J. Grant, A. Booth, A typology of reviews: an analysis of 14 review types and associated methodologies. Health Information & Libraries Journal, 2009. 26(2): p. 91-108.

[48] Y. Gavel, L. Iselid, Web of Science and Scopus: a journal title overlap study, Online Inf. Rev. 32 (1) (2008) 8–21.

[49] M. Gusenbauer, N.R. Haddaway, Which academic search systems are suitable for systematic reviews or meta-analyses? Evaluating retrieval qualities of Google Scholar, PubMed, and 26 other resources, Res. Syn. Meth. 11 (2) (2020) 181–217.

[50] G. Walker et al., Symmetries, expectations, dynamics and contexts: a framework for understanding public engagement with renewable energy projects. Renewable energy and the public. From NIMBY to participation, 2011: p. 1-14.

[51] Sanneke Kloppenburg, Marten Boekelo, Digital platforms and the future of energy provisioning: promises and perils for the next phase of the energy transition, Energy Res. Social Sci. 49 (2019) 68–73, https://doi.org/10.1016/j.erss.2018.10.016.

[52] Ruben Vicente-Saez, Clara Martinez-Fuentes, Open Science now: a systematic literature review for an integrated definition, J. Bus. Res. 88 (2018) 428–436.

[53] Mary Dixon-Woods, Debbie Cavers, Shona Agarwal, Ellen Annandale, Antony Arthur, Janet Harvey, Ron Hsu, Savita Katbamna, Richard Olsen, Lucy Smith, Richard Riley, Alex J Sutton, Conducting a critical interpretive synthesis of the literature on access to healthcare by vulnerable groups, BMC Med. Res. Methodol. 6 (1) (2006).

[54] Maarten Wolsink, Undesired reinforcement of harmful 'self-evident truths' concerning the implementation of wind power, Energy Policy 48 (2012) 83–87.

[55] Luis Mundaca, Henner Busch, Sophie Schwer, 'Successful' low-carbon energy transitions at the community level? An energy justice perspective, Appl. Energy 218 (2018) 292–303.

[56] Annabel Pinker, Tinkering with turbines: ethics and energy decentralization in Scotland, Anthropol. Q. 91 (2) (2018) 709–748.

[57] Jeffrey B. Jacquet, The Rise of "Private Participation" in the planning of energy projects in the Rural United States, Society Natural Resour. 28 (3) (2015) 231–245.

[58] Katrine Soma, Claire Haggett, Enhancing social acceptance in marine governance in Europe, Ocean Coast. Manag. 117 (2015) 61–69.

[59] Kyle Bassett, Lucas Semple, Wind turbine development for rural electrification in Nicaragua, Int. J. Environ. Stud. 69 (2) (2012) 338–349.

[60] Bob Evans, Judith Parks, Kate Theobald, Urban wind power and the private sector: community benefits, social acceptance and public engagement, J. Environ. Plann. Manage. 54 (2) (2011) 227–244.

[61] N. Hall, P. Ashworth, P. Devine-Wright, Societal acceptance of wind farms: Analysis of four common themes across Australian case studies, Energy Policy 58 (2013) 200–208.

[62] E. Chezel, O. Labussière, Energy landscape as a polity. Wind power practices in Northern Friesland (Germany). Landscape Research, 2018. 43(4): p. 503-516.

[63] Matthew E. Kahn, Local non-market quality of life dynamics in new wind farms communities, Energy Policy 59 (2013) 800–807.

[64] R. Steven Konkel, Renewable energy and sustainable communities: Alaska's wind generator experience, Int. J. Circumpolar Health 72 (1) (2013).

[65] Neil Simcock, Exploring how stakeholders in two community wind projects use a "those affected" principle to evaluate the fairness of each project's spatial boundary, Local Environ. 19 (3) (2014) 241–258.

[66] Diane Costello, Incorporating Community Governance: Planning Sustainable Energy Security, Int. J. Environ., Cult., Econ. Social Sustain. 7 (4) (2011) 349–365.

[67] Mhairi Aitken, Wind power and community benefits: challenges and opportunities, Energy Policy 38 (10) (2010) 6066–6075.

[68] Joshua A. Beery, Jennifer E. Day, Community investment in wind farms: funding structure effects in wind energy infrastructure development, Environ. Sci. Technol. 49 (5) (2015) 2648–2655.

[69] Charles R. Warren, Malcolm McFadyen, Does community ownership affect public attitudes to wind energy? A case study from south-west Scotland, Land Use Policy 27 (2) (2010) 204–213.

[70] Catriona Macdonald, Jayne Glass, Emily Creamer, What Is the Benefit of Community Benefits? Exploring local perceptions of the provision of community benefits from a commercial wind energy project, Scottish Geogr. J. 133 (3-4) (2017) 172–191.

[71] N. Guiney, The only green that matters is the green in your pocket: advocating for renewable energy in red states, Ecol. Law Q. 45 (2) (2018) 163–186.

[72] Martin Barry, Ralph Chapman, Distributed small-scale wind in New Zealand: advantages, barriers and policy support instruments, Energy Policy 37 (9) (2009) 3358–3369.

[73] Andreas Lindén, Lauri Rapeli, Andreas Brutemark, Community attachment and municipal economy: public attitudes towards wind power in a local context, Environ. Sci. Policy 54 (2015) 10–14.

[74] Alexandros Dimitropoulos, Andreas Kontoleon, Assessing the determinants of local acceptability of wind-farm investment: a choice experiment in the Greek Aegean Islands, Energy Policy 37 (5) (2009) 1842–1854.

[75] Carmel Anderson, The networked minority: how a small group prevailed in a local windfarm conflict, Energy Policy 58 (2013) 97–108.

[76] Kristian Borch, Mapping value perspectives on wind power projects: the case of the Danish test centre for large wind turbines, Energy Policy 123 (2018) 251–258.

[77] Chad Walker, Jamie Baxter, Danielle Ouellette, Adding insult to injury: the development of psychosocial stress in Ontario wind turbine communities, Soc. Sci. Med. 133 (2015) 358–365.

[78] Geoff A. Wilson, Sarah L. Dyke, Pre- and post-installation community perceptions of wind farm projects: the case of Roskrow Barton (Cornwall, UK), Land Use Policy 52 (2016) 287–296.

[79] R. Hindmarsh, Wind farms and community engagement in Australia: a critical analysis for policy learning, East Asian Sci., Technol. Soc. 4 (4) (2010) 541–563.

[80] Fritz Reusswig, Florian Braun, Ines Heger, Thomas Ludewig, Eva Eichenauer, Wiebke Lass, Against the wind: local opposition to the German Energiewende, Utilities Policy 41 (2016) 214–227.

[81] Chad Walker, Jamie Baxter, Procedural justice in Canadian wind energy development: a comparison of community-based and technocratic siting processes, Energy Res. Social Sci. 29 (2017) 160–169.

[82] Peter Karnøe, Raghu Garud, Path creation: co-creation of heterogeneous resources in the emergence of the Danish wind turbine cluster, Eur. Plann. Stud. 20 (5) (2012) 733–752.

[83] J. Thøgersen, and C. Noblet, Does green consumerism increase the acceptance of wind power? Energy Policy, 2012. 51: p. 854-862.

[84] D. Vecchiato, How do you like wind farms? Understanding people's preferences about new energy landscapes with choice experiments, Aestimum 64 (2014) 15–37.

[85] Antje Otto, Markus Leibenath, The interrelation between collective identities and place concepts in local wind energy conflicts, Local Environ. 19 (6) (2014) 660–676.

[86] Jøran Solli, Where the eagles dare? Enacting resistance to wind farms through hybrid collectives, Environ. Politics 19 (1) (2010) 45–60.

[87] Wendy Jepson, Christian Brannstrom, Nicole Persons, "We Don't Take the Pledge": environmentality and environmental skepticism at the epicenter of US wind energy development, Geoforum 43 (4) (2012) 851–863.

[88] S.H. Baker, Mexican energy reform, climate change, and energy justice in indigenous communities, Nat. Resour. J. 56 (2) (2016) 369–390.

[89] Anahita A. Jami, Philip R. Walsh, From consultation to collaboration: a participatory framework for positive community engagement with wind energy projects in Ontario, Canada, Energy Res. Social Sci. 27 (2017) 14–24.

[90] Anne Nygaard Tanner, Changing locus of innovation: a micro-process approach on the dynamics of proximity, Eur. Planning Stud. 26 (12) (2018) 2304–2322.

[91] Alain Nadaï, Olivier Labussière, Landscape commons, following wind power fault lines. The case of Seine-et-Marne (France), Energy Policy 109 (2017) 807–816.

[92] I. Oosterlaken, Applying Value Sensitive Dessign (VSD) to Wind Turbines and Wind Parks: An Exploration, Sci. Eng. Ethics 21 (2) (2014) 359–379.

[93] Ana João Gaspar de Sousa, Elisabeth Kastenholz, Wind farms and the rural tourism experience – problem or possible productive integration? The views of visitors and residents of a Portuguese village, J. Sustain. Tourism 23 (8-9) (2015) 1236–1256.

[94] N. Christie, et al., Co-location of activities and designations: a means of solving or creating problems in marine spatial planning? Marine Policy 43 (2014) 254–261.

[95] P. Devine-Wright, Public engagement with large-scale renewable energy technologies: Breaking the cycle of NIMBYism. Wiley Interdisciplinary Reviews: Climate Change, 2011. 2(1): p. 19-26.

[96] Ana Delicado, Luís Junqueira, Susana Fonseca, Mónica Truninger, Luís Miguel de Sousa Silva, Ana Horta, Elisabete Figueiredo, Not in Anyone's Backyard?. Science and Technology Studies 27 (2) (2014) 49–71.

[97] David Rudolph, Julia Kirkegaard, Ivar Lyhne, Niels-Erik Clausen, Lone Kørnøv, Spoiled darkness? Sense of place and annoyance over obstruction lights from the world's largest wind turbine test centre in Denmark, Energy Res. Soc. Sci. 25 (2017) 80–90.

[98] David Rudolph, Julia K. Kirkegaard, Making space for wind farms: practices of territorial stigmatisation in Rural Denmark, Antipode 51 (2) (2019) 642–663.

[99] J. Firestone, et al., Public acceptance of offshore wind power: does perceived fairness of process matter? J. Environ. Plann. Manage. 55 (10) (2012) 1387–1402.

[100] Jeremy Firestone, Willett Kempton, Meredith Blaydes Lilley, Kateryna Samoteskul, Public acceptance of offshore wind power across regions and through time, J. Environ. Plann. Manage. 55 (10) (2012) 1369–1386.

[101] Tara Hooper, Matthew Ashley, Melanie Austen, Perceptions of fishers and developers on the co-location of offshore wind farms and decapod fisheries in the UK, Marine Policy 61 (2015) 16–22.

[102] T. S. ten Brink, T. Dalton, Perceptions of commercial and recreational fishers on the potential ecological impacts of the Block Island Wind Farm (US). Frontiers in Marine Science, 2018. 5(NOV).

[103] Thomas Bauwens, Patrick Devine-Wright, Positive energies? An empirical study of community energy participation and attitudes to renewable energy, Energy Policy 118 (2018) 612–625.

[104] Thomas Bauwens, Boris Gotchev, Lars Holstenkamp, What drives the development of community energy in Europe? The case of wind power cooperatives, Energy Res. Social Sci. 13 (2016) 136–147.

[105] Fabian David Musall, Onno Kuik, Local acceptance of renewable energy—a case study from southeast Germany, Energy Policy 39 (6) (2011) 3252–3260.

[106] Ana Cravinho Martins, Rui Cunha Marques, Carlos Oliveira Cruz, Public–private partnerships for wind power generation: the Portuguese case, Energy Policy 39 (1) (2011) 94–104.

[107] N. Cullen, A. Bowden, and R. Spronken-Smith, Partnering between a geography department and a community initiative to provide a wind resource assessment for the Blueskin Bay region, Otago, New Zealand. New Zealand Geographer, 2012. 68 (1): p. 49-61.

[108] Sofia Avila, Environmental justice and the expanding geography of wind power conflicts, Sustain Sci 13 (3) (2018) 599–616.

[109] Ana M. Moragues-Faus, Dionisio Ortiz-Miranda, Local mobilisation against windfarm developments in Spanish rural areas: new actors in the regulation arena, Energy Policy 38 (8) (2010) 4232–4240.

[110] Lars Holstenkamp, Franziska Kahla, What are community energy companies trying to accomplish? An empirical investigation of investment motives in the German case, Energy Policy 97 (2016) 112–122.

[111] Neil Simcock, Procedural justice and the implementation of community wind energy projects: a case study from South Yorkshire, UK, Land Use Policy 59 (2016) 467–477.

[112] Lindsay Miller, Rupp Carriveau, Scott Harper, Innovative financing for renewable energy project development – recent case studies in North America, Int. J. Environ. Stud. 75 (1) (2018) 121–134.

[113] Franziska Wallmeier, Julia Thaler, Mayors' leadership roles in direct participation processes – the case of community-owned wind farms, IJPSM 31 (5) (2018) 617–637.

[114] Marie Hyland, Valentin Bertsch, The role of community involvement mechanisms in reducing resistance to energy infrastructure development, Ecol. Econ. 146 (2018) 447–474.

[115] Jürgen Meyerhoff, Cornelia Ohl, Volkmar Hartje, Landscape externalities from onshore wind power, Energy Policy 38 (1) (2010) 82–92.

[116] Pablo del Río, Anxo Calvo Silvosa, Guillermo Iglesias Gómez, Policies and design elements for the repowering of wind farms: a qualitative analysis of different options, Energy Policy 39 (4) (2011) 1897–1908.

[117] Benjamin K. Sovacool, Peter Enevoldsen, One style to build them all: corporate culture and innovation in the offshore wind industry, Energy Policy 86 (2015) 402–415.

[118] Katherine A. McComas, Richard Stedman, P. Sol Hart, Community support for campus approaches to sustainable energy use: the role of "town–gown" relationships, Energy Policy 39 (5) (2011) 2310–2318.

[119] Sara Heidenreich, Sublime technology and object of fear: offshore wind scientists assessing publics, Environ. Plan. A 47 (5) (2015) 1047–1062.

[120] Roopali Phadke, Public deliberation and the geographies of wind justice, Sci. Culture 22 (2) (2013) 247–255.

[121] M.T. Buntaine, W.A. Pizer, Encouraging clean energy investment in developing countries: what role for aid? Climate Policy 15 (5) (2015) 543–564.

[122] K. Grashof, Are auctions likely to deter community wind projects? And would this be problematic? Energy Policy 125 (2019) 20–32.

[123] Johannes Gamel, Klaus Menrad, Thomas Decker, Is it really all about the return on investment? Exploring private wind energy investors' preferences, Energy Res. Social Sci. 14 (2016) 22–32.

[124] Miranda J. Brady, Salma Monani, Wind power! Marketing renewable energy on tribal lands and the struggle for just sustainability, Local Environ. 17 (2) (2012) 147–166.

[125] Roopali Phadke, Defending place in the google earth age, Ethics, Place Environ. 13 (3) (2010) 267–281.

[126] Roopali Phadke, Steel forests or smoke stacks: the politics of visualisation in the Cape Wind controversy, Environ. Politics 19 (1) (2010) 1–20.

[127] Richard Hindmarsh, Hot air ablowin! 'Media-speak', social conflict, and the Australian 'decoupled' wind farm controversy, Soc. Stud. Sci. 44 (2) (2014) 194–217.

[128] Noreen Brennan, Thomas M Van Rensburg, Cyril Morris, Public acceptance of large-scale wind energy generation for export from Ireland to the UK: evidence from Ireland, J. Environ. Plann. Manage. 60 (11) (2017) 1967–1992.

[129] Ana Simão, Paul J. Densham, Mordechai (Muki) Haklay, Web-based GIS for collaborative planning and public participation: an application to the strategic planning of wind farm sites, J. Environ. Manage. 90 (6) (2009) 2027–2040.

[130] Robert Berry, Gary Higgs, Gauging levels of public acceptance of the use of visualisation tools in promoting public participation; a case study of wind farm planning in South Wales, UK, J. Environ. Plann. Manage. 55 (2) (2012) 229–251.

[131] Gawlikowska, A.P., et al., Visualisation and immersion dome experience for inspired participation. Journal of Sustainable Development of Energy, Water and Environment Systems, 2018. 6(1): p. 67-77.

[132] Tianhong Yu, Holger Behm, Ralf Bill, Jian Kang, Audio-visual perception of new wind parks, Landscape Urban Plann. 165 (2017) 1–10.

[133] Manyoky, M., et al., Developing a GIS-based visual-Acoustic 3D simulation for wind farm assessment. ISPRS International Journal of Geo-Information, 2014. 3 (1): p. 29-48.

[134] Wieduwilt, P. and P. Wirth, Cultural Heritage and Wind Turbines - A Method to Reduce Conflicts in Landscape Planning and Management: Studies in the German Ore Mountains. European Countryside, 2018. 10(4): p. 652-672.

[135] Marres, N., Issues spark a public into being: A key but often forgotten point of the Lippmann-Dewey debate. Making things public: Atmospheres of democracy, 2005: p. 208-217.

[136] Gillian Bristow, Richard Cowell, Max Munday, Windfalls for whom? The evolving notion of 'community' in community benefit provisions from wind farms, Geoforum 43 (6) (2012) 1108–1120.

[137] J. Leary, A. While, R. Howell, Locally manufactured wind power technology for sustainable rural electrification, Energy Policy 43 (2012) 173–183.

[138] Olivier Labussiere, Alain Nadai, Unexpected Wind Power 'Potentials': the art of planning with inherited socio-geographical configurations (France), Scottish Geogr. J. 130 (3) (2014) 152–167.

[139] Per Dannemand Andersen, Mads Borup, Thomas Krogh, Managing long-term environmental aspects of wind turbines: a prospective case study, IJTPM 7 (4) (2007) 339.