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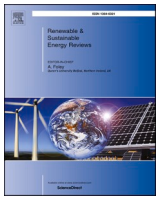

A matter of acceptability? Understanding citizen investment schemes in the context of onshore wind farm development

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ABSTRACT

Governments have set ambitious targets for low-carbon electricity, supported by policies that aim at accelerating the expansion of renewables like onshore wind energy. In-step with these developments it is acknowledged that community acceptance is an important factor. One measure deemed increasingly important for community acceptance is to encourage joint investments between local communities and wind farm developers. Through a literature review this study considers the synergies and mismatches of joint investments from residents, here referred as citizen investments, into developer-led wind farms. The practice of citizen investment into commercial wind developments is relatively novel but is becoming more relevant under policies which promote citizen involvement in renewable energy, such as the European Union's Renewable Energy Directive. This study conceptualizes citizen investment in the context of community acceptance to understand how it translates into eligibility criteria in different political and academic settings. This study finds that citizen investment has a positive relationship with community acceptance, but the link is conditional rather than automatic. This study sees the need to further elaborate on the nature of the relationship and highlights opportunities to bring together a variety of methodological, temporal and geographic approaches and theoretical concepts, considering the eligibility criteria and the trade-off between risks of citizen investments and control of projects.

1. Introduction

The growing urgency to constrain global warming to 2 °C above pre-industrial levels [1] has seen policies in many countries of the global north aim to increase the share of renewable energy sources to displace reliance on fossil fuels [2]. In many instances, national policy has set wind energy installation targets, which are anticipated to double current wind capacity by 2030 [3]. An important driver for the development of onshore wind farms can be the extent to which they are accepted by the community living near to a proposed site. Community acceptance is considered a prerequisite and accelerator for the continued expansion of wind energy [4]. Given that the largescale deployment of renewable energy requires the involvement of established incumbents [5,6] (e.g., municipal utilities, professional developers, multinational energy companies), policymakers and developers have introduced strategies to include citizens in the development of a project to foster community acceptance [7,8]. The policies have led to the emergence of a variety of collaborative models between local citizens and professional developers, including the opportunity for citizens to invest in local wind turbines [9,10]. The practice of citizen investment has expanded alongside the application of renewable energy auction policies, particularly in Europe [11,12].

A number of high-potential wind regions have either implemented, formalized or proposed citizen investment models, including Denmark [13], Canada [14], and Scotland [15]. These examples emphasize the role of citizen participation and stakeholder benefit within the framing of a just transition agenda [16–18]. This study focuses on community acceptance in the context of collaborative approaches to wind farm development requiring citizen investment which could contribute to the Sustainable Development Goals 7 (renewable energy), 9 (innovation and infrastructure), 13 (climate action) and 16 (peace, justice and strong institutions).

Abbreviations: CEDIF, Community Economic Development Investment Fund; COMFIT, Community Feed-in Tariff scheme; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; SDG, Sustainable Development Goal; UK, United Kingdom.

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Understanding why and under which conditions citizen investment influences the local acceptability of a largescale wind farm (i.e., the level of support from within a group of nearby residents) is an important question for academics, policymakers, and developers [19–23]. The review examines the ways in which citizen investment is interpreted and discussed with focus on the representation of eligibility considerations within the research. This review identifies implications for policy and future research regarding the local acceptability of citizen wind energy investment models.

With focus on projects owned by people living within a specific geographic area, Baxter et al. [10] and Lowitzsch et al. [24] have identified common themes which influence citizens' involvement in renewable energy developments. Each of these papers gives focus to common issues, including (i) actor representation and the heterogeneity of investors; (ii) the proximity criteria describing how far an investor lives from a development; (iii) the distribution of ownership rights governing the asset and (iv) the legal framework and formal voting structures which determine who is eligible to engage in, or vote on, renewable energy developments. In recent years, European policy under the Recast Renewable Energy Directive, Clean Energy Package and Green Deal have seen a greater number of hybrid arrangements emerge to share the ownership of a particular project between larger-scale market players and citizen initiatives within a certain geography. As various approaches have noted, citizen investment requires trade-offs between different criteria for local acceptance [25]. Within this context, the review aims to test the hypothesis that community acceptance is positively enhanced by citizen investment mechanisms. To examine community support for citizen investment, the analysis gives specific focus to their defining eligibility criteria. The study asks:

1. How is citizen investment into wind farms translated into eligibility criteria?
2. Are there common lessons as to the perceived local acceptability of a citizen investment scheme?

To address these aims, this study identifies papers that concern citizen investment or related local investment schemes ('community ownership' or 'co-ownership') into onshore wind farms through a systematic approach of original research published until June 2022. This paper proceeds as follows. Section 2 describes the emergence of citizen investment into wind farms. Section 3 contains details about the methodology and review approach and subsequently, Section 4 contrasts and discusses the findings of each paper. Section 5 contains a conclusion of the core findings and opportunities for future research.

2. Background: types of citizen investment into wind farms

Financing the energy transition critically depends on tapping new financing sources [26,27], including citizen investment from remote or even international investor pools. Citizen investments are hybrids between fully community- and developer-owned projects [16] in which investors and investments extend over increasingly disperse geographic scales [28]. They require the citizens to make an active contribution to a wind farm by investing their own capital in the project [29].

Citizen investments can have advantages for the community compared to projects developed on their own (community energy). Haggett and Aitken [30] report that communities have difficulties in securing finance and that perceived risks of projects create challenges. Recently, policy changes including the introduction of auctions have replaced feed-in tariffs in many countries, which puts additional challenges onto community energy [11,12]. Haggett and Aitken [30] and Hinshelwood [31] have described that a cooperation between developers and the local community in a project does not require the community to solely bear the full risks, resources, knowledge, time, and start-up capital as if they developed a project on their own. A developer usually has more resources [32] and has greater ability to bear project risks if a community and a developer enter into a citizen investment scheme and share ownership of the wind farm together [33,34]. Citizen investments therefore provide financial benefits to communities and advantageously use the capacity that usually only established market players have [35].

Table 1 shows various forms of citizen investment allowing different degrees of formal voting rights and control. Equity (i.e., common equity) is a traditional equity investment, which grants the shareholder proportional voting rights [36]. Citizen investors may purchase shares in a project as an individual. Different arrangements are possible, for instance split ownership [37,38] and limited partnership [20]. A common alternative is a cooperative structure under the 'one person, one vote' rule [39]. Investments in equity have a level of risk for citizen investors "because the owners are the party responsible for bringing the initial concept idea through development, construction and commercial operation" (p. 10) [36]. Crowdfunding in debt and bonds usually come at a later project phase [25]. Investors do not have to bear the same risks as (early) equity investments, and do not necessarily gain legal voting rights. Similarly, preference equity and shared revenue agreements [37,40], (profit) participation rights and subordinated loans [20] do not automatically confer voting rights to citizens on a legal basis. As such, the appointment of a local representative to meetings concerning majority private project developments is done on a voluntary basis, as part of wider stakeholder engagement strategies. In some instances, a public body such as the municipality might make an investment on behalf of residents in the area [20,41], for example through a joint venture [37,40].

These citizen investment arrangements are distinguished from other forms of benefit-sharing arrangements in which the developer provides financial benefits to individuals (e.g., discounts on electricity, compensation for property value-loss) or collectively for the community as whole (e.g., local community benefit fund). Similarly, contributions might be made in-kind, such as local projects for infrastructure development, facilities, or services.

Kerr et al. [42] describe that citizens' entitlement to financial benefits from onshore wind farms can be contingent on the voluntary contribution of a developer or formalized on a legal basis. The state of Mecklenburg-Western Pomerania [56] or the COMFIT program in Nova Scotia [14] are two examples where citizen investments are mandated or at least strongly encouraged by the legislative authority. However, citizen investments are in most instances voluntary and the type of

Table 1
Overview of citizen investment models and benefit-sharing schemes from developer-owned onshore wind farms.

	Citizen investment models	Benefit schemes
Definition following Kerr et al. [42]	"Financial benefit is directly linked to the profitability of the development"	Provided from the developer as "standardised payments/internal budget allocation"
Citizens/ individuals (Payment made *directly* to citizens/ individuals)	***Equity*** Split ownership [37,43] Cooperatives [44] Shared equity [45] Joint ventures [37,43,45] ***Debt/crowdfunding*** Revenue-sharing agreements/Shared Revenue [37,43]	Discounted electricity [46,47] Compensation [48,49]
A defined group of recipients (Payment made *indirectly* to the community)	***Equity*** Municipal stakeholders, e.g., shareholding through public utilities [50,51] Trusts [52]	Community benefit fund [48,53] Payments to municipalities and benefits in kind [54,55], e.g., sponsoring of associations or local community facilities (e.g. kindergartens, swimming pools, scholarships)

arrangement is freely negotiable between the project developer and the local community [57,58]. A major motivation for developers to offer citizen investments on a voluntary base is towards enhancing community acceptance [59].

3. Methodology

To contribute to a fuller understanding of how the implementation of citizen investment into onshore wind influences community acceptance of specific projects, this study is a review of empirical research published to June 2022. The research problem involves the identification and comparative case review of literature which considers the locality, participatory and distributive implications of shared wind farm development by local citizens and professional developers through citizen investment into a particular wind farm asset, with attention to relevant frameworks on the topic (i.e. [9,10,24]).

3.1. Approach to the review

This review sourced relevant empirical studies from three comprehensive journal search engines (Web of Science, Scopus and Google Scholar). Papers were screened along criteria consistent with the PRISMA principles (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) [60]. The PRISMA methodology is considered best practice for reproducibility and quality of analysis. The Boolean search criteria shown in Table 2 were used to identify relevant empirical research.

The search query criteria were selected as follows. This work focuses on the emerging practice of citizen investment into onshore wind energy under the first tier search term “wind”. Second, since this paper deals with citizen investment, keywords “investor”, “investment”, and “invest” are included in the second tier. Wider exploratory search queries also considered “ownership”, “cooperative”, “crowdfunding” and “finance” as keywords and were found to be unnecessary from review at a preliminary stage since relevant papers were already found using the keywords given in Table 2. Third, the paper considers the local community and its individuals. The keywords “local”, “private”, “individual”, “citizen” and “community” were intended to ensure that local (i.e., potential investors associated with a community of locality) made up the sample. This excludes studies concerning “distant” investors from further away, such as institutional or professional investors. The fourth tier search term addresses community acceptance of wind energy. Therefore, “acceptance” is used as a key search term for all search phrases and in most instances served to exclude purely technical papers about wind energy. Further to this, preliminary analysis revealed contextual particularities, for instance referring to community acceptance as a “social licence to operate” [61] and a subset of European studies which focalized on this manifestation as levels of “acceptability” [62–64]. For robustness, these terms and alternative spellings were added into the search expansion criteria outlined in Table 2. However, any research outside of these criteria would not have been included in the identified sample taken forward for analysis.

Table 2
Search word combinations.

(First tier)	AND (Second tier)	AND (Third tier)	AND (Fourth tier)
Wind	Acceptance OR Acceptability OR License	Investor OR Investment OR Invest	Individual OR Private OR Community OR Citizen OR Local

3.2. Identifying relevant empirical studies

Fig. 1 shows a numerical summary of the screening process. In total, the search by keywords yielded 138 publications in Web of Science and 67 in Scopus, which resulted in 142 unique search results. The initial relevant sample (142) was analyzed for term co-occurrence using bibliometric clustering in VOSviewer to show links between keyword and title terms (Appendix A Fig. 1). A total of 740 terms were identified using a full counting approach, and 71 occurred at minimum 3 times. Of the 5 identified clusters, 4 respectively contained dominant co-occurrence nodes at “investments”, “wind power”, “energy policy” and, having emerged more recently (average publication year 2016 onwards), “social acceptance” connected to “community acceptance”. Based on the co-occurrence map analysis and after screening titles and abstracts of the relevant sample, studies were shortlisted under inclusion/exclusion criteria to a potentially eligible list of 18 original empirical journal articles.

An analysis of these 18 full papers resulted in 7 papers from the databases. The final sample of 13 papers contains these seven papers and additionally one from Google Scholar and five from citation searching.

Fig. 2 summarizes the inclusion and exclusion process undertaken to identify a sample of relevant studies. Empirical papers presenting original quantitative, qualitative, and mixed methods evidence were included. Reviews and conceptual papers are only used as a source for references in the snowballing procedure to identify further relevant publications or for conceptual considerations.

The inclusion and exclusion of papers was as follows. First, the state of energy systems concerning security of supply, affordability and environmental compatibility and the challenges related to the energy transition vary greatly between countries [65]. For a coherent sample of papers in terms of the development status of the considered energy system and associated challenges to community acceptance of the transition, this study only considers countries which have similar preconditions. It uses the Energy Transition Index 2020 as a proxy for the analysis and focus on advanced economies with established energy systems [66].

Second, this study considers onshore wind energy development only, as there are significant differences in the typical investment scale [36] and proximity between residents and turbines [67] compared to offshore wind farms. Papers that addressed at least two different forms

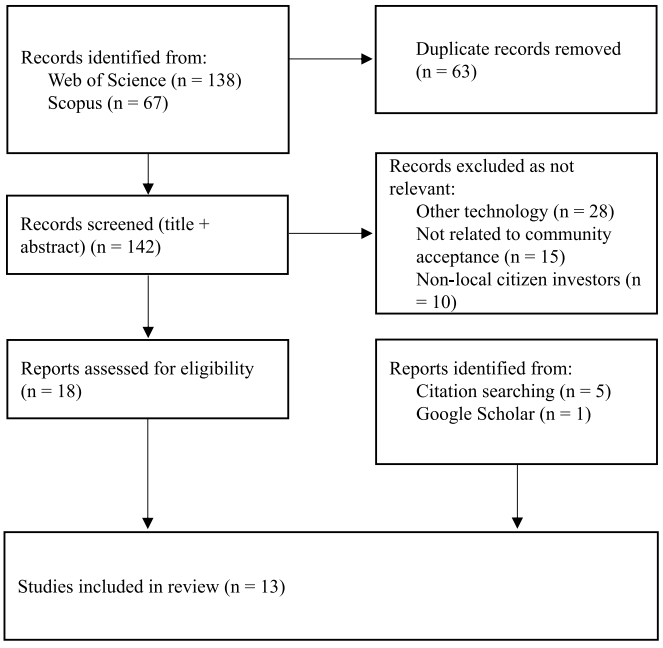

Fig. 1. Overview of the screening process.

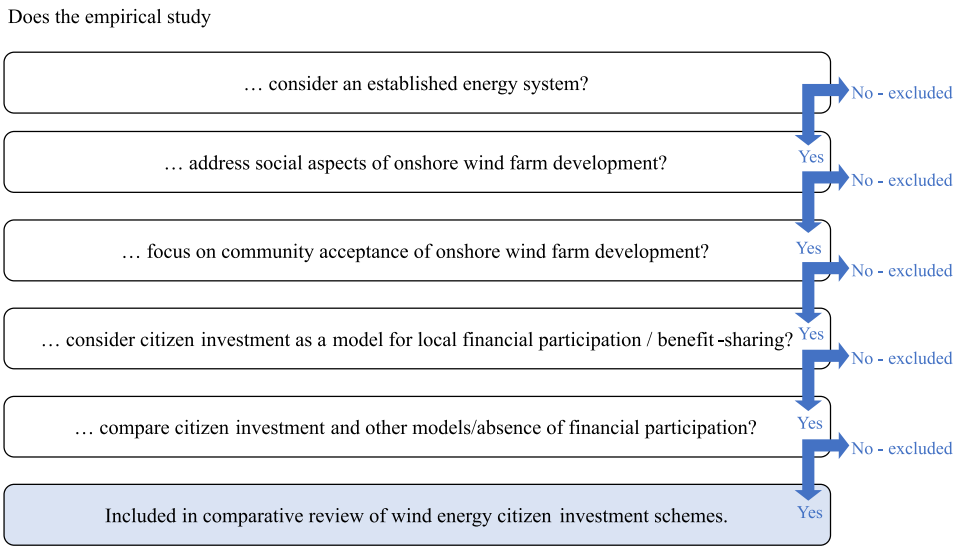

Fig. 2. Aims of inclusion and exclusion criteria applied during screening to identify relevant studies.

of financial participation are included, to consider citizen investment in the context of an alternative financial participation scheme. Therefore, included studies concerned (1) at least two citizen investment models, or (2) a citizen investment model and a benefit scheme, or (3) a citizen investment model in contrast to no financial participation scheme.

Two independent researchers were involved in the selection, analysis and cross-comparison of the findings of the collected papers and all articles deemed relevant were considered by qualitative analysis [68]. Table 3 shows the sample of papers included in the review.

4. Results and discussion

This analysis is contained within the search criteria established at the beginning of the research, and therefore it is necessary to note the limitations of the data that may influence the results. Much of the identified research focuses on policy cases that already have some experience with citizen investment. It is conceivable that there are other countries that have introduced citizen investment but are not represented, for instance where this has not met with much social interest or where citizen participation in renewable energy development is novel. The underrepresentation of empirical papers on the topic beyond Northern America and Europe has been recognized elsewhere [18]. Limitations of this nature commonly arise with socially innovative topics and highlights new areas of research which might make generalization possible in the future.

4.1. Terminology applied to citizen investment into wind farms

The findings presented in Table 4 highlight that citizen investment into wind farms covers a varied terminology and a number of debt or equity financial investment mechanisms. Illustratively, several papers use more than one term to refer to citizen investment within the text.

Citizen investment into wind farms is commonly referred to in the literature as "community/local (co-)ownership" [69,70,72,74,75,77,79–81]. This suggests that studies concerned with citizen wind energy investment has drawn on the terminology introduced under some of the earliest policies, as in Denmark [79], even if in practice some citizen investors do not feel a sense of "ownership" of the project and the investment may be sourced from outside of the "local" community [75].

Procedural dimensions of ownership are explicitly brought to the fore in several instances. For example, this strand of the literature describes citizen investment as "cooperation" models [81] and "shared ownership" arrangements [71,76] which encourage "citizen participation" in the energy transition [71]. Procedural aspects are especially evident for research focusing on Germany, with citizen investment into wind farms referred to as a mode of "financial participation" [77] and "active participation through financial investment" [73].

Alongside this, another focus within the literature considers the specific ways in which shareholding is structured, for instance through a "joint venture" [76], "investment by local residents" [82], "equity investment/involvement" [69,76,80], "(wind) bonds" [78,80], and "revenue sharing" [81]. This indicates that there are a number of financial mechanisms to enable citizen investment into wind farms owned by commercial wind farm developers, each of which carries specific implications and limits for the extent of citizen involvement in the project.

4.2. How is citizen investment into wind farms translated into eligibility criteria?

The following sections aim to distinguish how these different papers define citizen investment models in terms of (i) actor representation, (ii) the conceptualization of the proximity criteria applied to include stakeholders, (iii) the distribution of ownership rights governing the asset, and (iv) the legal framework which determines who is eligible to vote.

In some cases, where the national legal requirements for citizen investments have not been unified or their access has not been restricted, there is evidence to suggest it is not necessarily the local community that invests and benefits to the greatest extent from citizen investment models. Citizen investment, even if framed as community ownership, does not necessarily mean such a "community" comprises residents in the immediate vicinity of a project. As Musall and Kuik [70] state, the distinction "between communities of interest" and "communities of localities" is crucial for answering who invests and benefits (p. 3253). Profits in their community co-owned case are used to "reduce the fees for the local kindergarten, thus providing financial relief to the parents" (p. 3255). Warren and McFadyen [69] state that "potential economic benefits (…) can flow to locals from community ownership (…) involving job creation, in-migration and growing numbers in the local school" (p. 210). This perception of "local benefits" regards the whole community and might reflect that the funding comes not directly from individuals but from a local trust. Citizens could not invest directly.

Some papers define the community eligible to invest geographically, and point to local citizens as the community living within a given radius of a wind project. Tanujaya et al. [80] performed a survey of "local

Table 3
Overview of the reviewed papers.

Papers	Country/case	Method	Population and sample size	Proximity to the project	Sample strategy	Analysis
Warren and McFadyen [69]	Scotland	Ex post 1) Questionnaire-based survey (online and paper) 2) Semi-structured face-to-face interviews	1) Local residents (n = 68) 2) Tourists (n = 38) of the isle of Gigha and Kintyre peninsula 3) Interviews with key stakeholders (n = 5)	Approximately 4–6 km	Non-probability sampling: 1) Door-to-door 2) Face to face (downtown) 3) Online	Descriptive
Musall and Kuik [70]	Germany	Ex post Questionnaire-based survey (in-person)	1) Nossen residents (n = 100) 2) Zschadraβ residents (n = 100)	Close proximity to the community and 2 km (but not visible)	Door-to-door interviews following letter circulated by respective mayors (samples confirmed equivalent in age, gender and level of education)	Kruskal–Wallis one way analysis of variance
Goedkoop and Devine-Wright [71]	United Kingdom	Ex post 1) Semi-structured interviews (face-to-face and telephonically) 2) Informed by community energy seminar	Shared ownership stakeholders: 1) Renewable energy companies (n = 7) 2) Community actors involved in specific projects (n = 6) 3) Intermediaries for advisory/support (n = 6)	Policy focus (Refers to Danish case: within 4.5 km)	Snowball sampling through a referral system	Interviews coded for thematic analysis of discourse from a social constructionist perspective using Atlas.ti
Mostegl et al. [72]	Germany	Ex ante 1) Three workshops (informative format) 2) Questionnaire-based survey and a choice experiment (online and paper)	Households in community of Langqauid (n = 231)	56.6 km^2 covering the community border as per OpenStreetMap	Total population: 1) Mailshot-invitation 2) Questionnaire link on social media platform 3) Questionnaires at local organizations and businesses	Latent class choice model
Langer et al. [73]	Germany	Ex ante Choice experiment with survey through web-survey	National (n = 1363)	Attribute levels from 0 to 0.5 km to > 10 km of attribute distance	Quota Sampling: Respondents filtered by degree of experience with participation in wind energy by market research company	Multinomial logit choice model using Hierarchical Bayes estimation
Brennan et al. [74]	Ireland	Ex ante Five focus groups (in person) and a public survey	1) Residents who live near windfarm (n = 13), Wind farm developers (8) and 2) Individuals in case study locations (n = 200)	Close proximity to the community	1) Voluntary response sampling after pre-survey for focus group, 2) not specified survey	1) Not specified in detail (focus groups) and 2) Descriptive (survey)
Walker and Baxter [75]	Canada	Ex post Comparative case study of Nova Scotia and Ontario communities using interviews and survey	1) Focus groups: Residents of cases residents living within 2 km of a wind turbine (n = 31), Municipal leaders (n = 10), Developers (n = 7), and Policy experts (n = 6) 2) Quantitative survey: Ontario (n = 127) and Nova Scotia (n = 113) residents within 2 km	Residents within 2 km of a turbine	1) Voluntary response to mailshot-invitation and snowball sampling through a referral system 1) Random mailshot-invitation to residents living within 2 km of a turbine across 10 communities	1) Interviews coded using inductive grounded theory approach in NVivo 2) Survey data analyzed by t-tests and regression
Hyland and Bertsch [76]	Ireland	Ex ante Online survey	National (n = 1044)	Public focus	Random sampling from panel book by market research company	Ordered logit model
Lienhoop [77]	Germany	Ex ante 1) Choice experiments 2) Focus groups	1) Residents in three villages with significant wind energy potential in the federal states Saxony (n = 15), Saxony-Anhalt (n = 15) and Hesse (n = 15) 2) Rural residents living in communities with wind energy potential (n = 388)	Public focus	Sampling by market research company to ensure even age and gender distribution	1) Descriptive analysis (focus groups) 2) Mixed logit choice model
Vuichard et al. [78]	Switzerland	Ex ante Online experimental survey	National (n = 1202)	Public focus	Random sampling from panel book by market research company	Analysis of variance (ANOVA)
Leer Jørgensen et al. [79]	Denmark	Ex post Comparative case study of three projects in west, east and south Denmark using focus	Citizens of the three case studies (two focus groups for each case: n = 46, Interviews: n = 14)	Community focus (policy case: eligible within 4.5 km, with donated shares to	Purposeful sampling based on distance to turbine, citizens identified through newspaper articles, word-of-mouth, and Google Maps	Interviews coded for thematic analysis of (1) perceptions of wind projects and (2) distributive fairness of compensation schemes in

(*continued on next page*)

Table 3 (*continued*)

Papers	Country/case	Method	Population and sample size	Proximity to the project	Sample strategy	Analysis
		groups and semi-structured interviews		households within 1 km)	and followed-up by telephone contact.	NVivo to draw a Toulmin's model of a simple argument combined with a hermeneutics-inspired meaning interpretation
Tanujaya et al. [80]	South Korea	Ex ante 1) Choice experiment and survey of general public 2) Face-to-face interviews of local residents	1) National sample (n = 508) 2) Residents within 1 km of renewable energy projects (n = 306)	Comparative focus: Public sample and within 1 km	1) Random proportional quotas (national) 2) Purposive quota (residents)	Multinomial logit choice models
Vuichard et al. [81]	Switzerland, Estonia and Ukraine	Ex ante Choice experiment and survey (online)	National: Switzerland (n = 1003), Ukraine (n = 500) and Estonia (n = 500)	Public focus	Random sampling from panel book by market research company	Multinomial logit choice model using Hierarchical Bayes estimation

residents" living in administrative areas "within 1 km" of renewable energy infrastructure (p. 6) for a South Korean sample. Leer Jørgensen et al. [79] discusses the Danish co-ownership scheme requiring developers to offer 20% of a project to "local [permanent residents] within 4.5 km" [79] as purchasable shares priced at closing bid (cost) price.

Walker and Baxter [75] discuss local perceptions of different wind energy projects in Ontario and Nova Scotia through interviews and surveys with "residents living within 2 km of a wind turbine" under different community-based ownership policies. The study presents various aspects of the Nova Scotia Community Feed-in Tariff scheme (COMFIT). It highlights that in some investment options (i.e., the Community Economic Development Investment Fund, CEDIF), only 25 investors and 6 directors must be from the "defined community", while "the rest can be from anywhere in the province" (p.761) [75]. Interviewed policy experts and residents confirmed that investors are generally from outside the local project. That policies such as these are consistent with a legal definition of majority community ownership was criticized by some respondents. In a similar fashion, Goedkoop and Devine-Wright [71] found that communities would likely find it "impossible" for local residents "to raise sufficient capital to provide their share of a larger project, this could necessitate opening up share offers to individuals living outside of the local area" (p.142). The study also describes potential citizen investors as "highly educated, middle aged" residents with disposable income, which was a concern echoed by focus group participants interviewed by Lienhoop [77]. Lienhoop [77] further names "rural residents living in communities with wind energy potential" as likely beneficiaries (p. 101) but highlights German federal regulation in Mecklenburg-Western Pomerania focuses on residents within a 5 km radius of a development.

In contrast, other paper are less specific as to eligibility criteria and intended benefit. Hyland and Bertsch [76] framed questions by defining "local" Irish communities and residents as those who "may be affected (…) when new wind farms are developed" (p. 457). Vuichard et al. [78] state that community members (from the municipality) could invest, similar to Mostegl et al. [72] who mention community ownership. Both do not specify further the benefits of that investment for citizen investors. Individuals from the region could potentially invest in Vuichard et al. [81] but they give no reference to benefits. Instead, benefit schemes are a separate category from citizen investments. Langer et al. [73] refer to a wind farm in the neighborhood but do not clearly define who could invest. However, another attribute in the study mentions a distance up to 10 km or even more between the turbines and residences.

There are different approaches and timings used among the sample which can be divided mainly ex ante and ex post. Warren and McFadyen [69] and Musall and Kuik [70] compare community energy and developer-led projects by comparative case studies of projects after commission. Walker and Baxter [75] analyzed several projects in two provinces in Canada, Nova Scotia and Ontario. Leer Jørgensen et al. [79] conducted focus group interviews with Danish local residents. Brennan et al. [74] investigated a large project in the Midlands by three developers that aimed at the export of electricity from Ireland to UK which is currently on hold. Goedkoop and Devine-Wright [71] interviewed UK stakeholders with industry, community and advisory backgrounds. Other studies are ex ante. Mostegl et al. [72] focus on a Bavarian community in Germany where the municipality aims to build renewable energy. It is a hypothetical project, but the municipality supports the study. Most common ex ante studies are (online) surveys [73,76–78,80,81].

4.3. *Are there common lessons as to the perceived local acceptability of a citizen investment scheme?*

The studies in this review show varying degrees of associations between citizen investment and community acceptance of wind turbines. Warren and McFadyen [69] and Musall and Kuik [70] both find that ownership has a positive effect on community acceptance. Mostegl et al. [72] focus on 'community ownership' and 'external investors'. The former performs significantly better in terms of utility, indicating that there is a strong preference for community-led projects, especially due to household savings accrued as revenue under a community ownership model. Very positive associations are reported by Warren and McFadyen [69] and Musall and Kuik [70] with statements that citizens felt pride in their respective local wind farms.

Furthermore, these papers emphasize the existence of a strong will and support in the local community and municipality to build wind farms. For example, Mostegl et al. [72] state that the local council gave a great deal of support to the project, through collaborative planning, consultation and engagement of an interested panel of local citizens. Warren and McFadyen [69] make similar reports, stating that the community made a "bold initiative … to take charge of their own destiny" (p. 207) to counteract socio-economic downturn, job-loss and out-migration. Musall and Kuik [70] refer to an "ambitious energy concept" (p. 3254) initiated by the community after a devastating flood. The authors do not directly refer to fairness, trust or risk, but make reference to the planning process stating that the respondents perceived it as more transparent, despite not having a "distinct information campaign by the community authority" (p. 3258). These are not reported for the private ownership case. The authors explain that this positive perception might be due to the fact that issues were discussed within the community at a local club and foundation. Musall and Kuik [70] state that the project saw the "reinvestment of the profits to the benefit of the local population" (p. 3259).

Many papers find a conditional relationship between citizen investment and community acceptance. Walker and Baxter [75] analyzed two

Table 4
Overview of the eligibility criteria of the reviewed papers.

Papers	Terminology applied to citizen investment	Actor representation	Conceptualization of proximity criteria	Distribution of ownership rights	Type of model and control (legal framework)
Warren and McFadyen [69]	Community ownership	1) Community raises capital cost through three-way mix of grant funding, commercial loan finance and equity finance 2) Commercial developer	Community of place (islands)	1) Wholly owned by the community 2) Commercial developer	1) Community-owned windfarm 2) Developer-owned windfarm
Musall and Kuik [70]	Community ownership Co-ownership	1) Community through a community club and a foundation 2) Commercial developer	Community of locality	Community co-ownership (80% owned by developer, 15% belong to a foundation and 5% belong to the club 'rural life' (equals 20% ownership through the community)	1) Community co-ownership 2) Commercial wind farm
Goedkoop and Devine-Wright [71]	Shared ownership Citizen participation	Community and commercial developer	Communities (defined as a collective rather than an aggregate of individuals)	Local share between 5 and 25%	1) Community-owned wind farm: 2) Commercial wind farm with elements of shared ownership and control
Mostegl et al. [72]	Community ownership	Community and investor	Residents of municipality	Community ownership model not specified	1) Community ownership model 2) External investor model 3) Household Savings from Revenue in community ownership model (10%, 25%, 35%, 50%) 4) Price of electricity
Langer et al. [73]	Active participation through financial investment	Community and commercial developer	Neighborhood	Not specified	Financial investment
Brennan et al. [74]	Investment by local residents Co-ownership Ownership by the community	Community and commercial developer	Affected public: local community who lives in proximity to a wind farm/ planned wind farm	Not specified but one suggestion: 10% open to community	1) Community co-ownership 2) Compensation 3) Investment with guaranteed return
Walker and Baxter [75]	Minority or majority community ownership Community-based development	Community and commercial developer	Community of place, citizen investors are not necessarily local	Different; from 0 to majority stake (51%)	1) Community-owned (compensation and investment (CEDIF in Nova Scotia)) 2) Developer-led with very little profit sharing with community (mainly Ontario)
Hyland and Bertsch [76]	Joint venture Equity involvement Shared ownership	Community and commercial developer	Residents of the local communities	Not specified	1) Community benefit scheme 2) Equity involvement (co-ownership) 3) Joint ventures (co-ownership) 4) Energy cooperatives (community ownership)
Lienhoop [77]	Financial participation Co-ownership through shareholding	1) National (large enterprise) 2) Regional (e.g., public services) 3) Local (e.g., community wind park)	Rural residents	Not specified	1) Option to buy shares (co-ownership) 2) No option to buy shares
Vuichard et al. [78]	Community investment via shares or bonds	Local project developer and residents of the local communities	Residents of the local communities	1) Individuals, community members 2) Individuals, community members 3) Community as a whole	1) Wind share (co-ownership) 2) Wind bond 3) Wind resource tax
Leer Jørgensen et al. [79]	Co-ownership schemes	External developer and external and local investors.	Local citizens within 900 m, 4.5 km and more than 4.5 km	Three cases: from fully owned by local citizens to less than 10%	1) Property value-loss scheme 2) Co-ownership scheme 3) Green scheme (community benefit)
Tanujaya et al. [80]	Community-based Bond investment Equity investment	Not specified	Residents within 1 km	Not specified	Bond investment Equity investment (co-ownership)
Vuichard et al. [81]	Local ownership Cooperation Revenue sharing	Residents and commercial developer	Residents of the local communities	(1) Individual(s) from the region (2) Local electric utility (3) Cooperation between local utility and a specialized investor	1) No benefits to local community 2) Benefit-sharing with local landowner 3) Benefit-sharing with municipality 4) Benefit-sharing with individual residents

provinces in Canada, Nova Scotia and Ontario. The majority of the citizens were in favor of citizen investments, but both proponents and opponents pointed to caveats. The authors found concerns about fair distribution of benefits and that citizens are frequently not aware of the opportunity to invest. Another aspect of concern was that not only local citizens invested into the citizen investment schemes. Some participants expressed that the cases were not grass-roots developments but were "brought to the communities by outside interests" (p. 764).

Brennan et al. [74] investigated a large project in the Midlands by three developers that aimed at the export of electricity from Ireland to UK. This paper explores various ways in which the considered community would benefit from electricity discounts, community benefit funds, individual compensation and citizen investment. The Midlands project is currently on hold and therefore no specific offer had been made to communities at the time of the study. Both public stakeholders and wind farm operators in the focus group discussions were supportive of shared governance initiatives in principle. However, some residents were skeptical that the developers would cooperate with them. Nevertheless, local independent developments were not an alternative either as community respondents showed apprehension about high risk and complexity of wind energy projects, as well as the time before financial returns can be realized. Another issue was that some participants felt it to be unfair that turbines were located in their community without them benefitting from electricity generation.

A lack of trust is also an element discussed by Goedkoop and Devine-Wright [71]. The authors interviewed UK stakeholders with industry, community and advisory backgrounds to investigate how shared ownership was interpreted by these individuals. The authors highlight a lack of trust in the viewpoints of different stakeholders. Some developers expressed skepticism about the capabilities and representativeness of community stakeholders, and some community stakeholders viewed developers as primarily profit-driven, with a likelihood to instrumentalize communities to gain their approval for planning. Overall, the authors conclude that shared ownership is difficult in practice and that a lack of trust at the project level can undermine cooperation. However, there is some evidence that citizen investment can have a positive effect , in particular when "partnerships are negotiated between developers that express a normative rationale for community engagement and pragmatic community actors that are prepared to accept what developers might offer" (p. 144).

Hyland and Bertsch [76] compare a community benefit scheme, equity involvement (co-ownership), joint ventures (co-ownership) and energy cooperatives (community ownership). They carried out an experiment among Irish citizens and found that when the depth of involvement increases, the acceptance of citizen investment models decreases. Given that risk tends to increase with greater levels of control over the project, Hyland and Bertsch [76] find that citizens prefer forms of participation with less active involvement. However, they still found a 39% increase in acceptance for equity involvement, 36% for joint venture and 38% for a cooperative compared to no opportunity for citizens to financially participate in a wind farm. The authors discuss risk aversion, lack of trust, or perceived unfairness as potential explanations, but did not survey these variables.

Vuichard et al. [81] compare different forms of ownership and distribution of benefits. They distinguish between ownership of individuals from the region, a local electric utility, cooperation between local electric utility and investor, and a foreign energy company. They showed in a choice experiment among Swiss, Estonian and Ukrainian respondents that citizens from Switzerland and Ukraine have a negative perception, and from Estonia a positive perception, of ownership by individuals from within the region of wind farm developments. Contrary to this, ownership models by a local electric utility or cooperation including a specialized investor were preferred. The least preferred option was ownership by a foreign energy company. Overall, other attributes relating to the distribution of benefits and governance processes were less important than citizen investment, while ecological and visual impact were the most important attributes of those included.

Lienhoop [77] explored local public preferences for different forms of financial and procedural participation through choice experiments and focus groups with German residents living in communities with significant wind energy potential. The study considered a local business tax, compensation payments and co-ownership as mean of how the community can get involved. The authors report that interest in co-ownership was generally low and the perceptions about this form of financial participation were mixed. It is reported that "there was an overall concern that shares are a risky investment and there was no interest to participate in the potential losses of the wind energy project" (p.101) which was associated with the bankruptcy of a prominent national energy developer. Some citizens perceived a community wind farm or a regional developer to be more trustworthy, but "only a minority" were interested in actually participating through shareholding. Among the financial models, the authors report there was some preference for citizen investment opportunities, but it was not very strong.

Langer et al. [73] consider different forms of participation to examine which form has the greatest potential to increase community acceptance. They found that financial participation has a small positive marginal utility and conclude that "citizens may not have sufficient knowledge about wind energy investments, may be afraid to invest in wind energy projects, or have little or no trust in wind energy companies or operators" (p. 68). Tanujaya et al. [80] and Vuichard et al. [78] found only minor effects of citizen investments on community acceptance. Both studies entailed an experimental setting distinguishing between different citizen investment models.

Tanujaya et al. [80] conducted an experiment in South Korea with two different populations. The first comprised residents in regions with existing renewable energy projects. The other was made up of a nationally representative sample. The authors considered bonds and equity models. However, the statistical analysis of the experimental data revealed no significant effect for both citizen investment models.

Vuichard et al. [78] considered benefits to the community living nearby in general (through taxes of the wind farm) and individuals in this community (through investing in shares or bonds). They conducted a survey and experiment among a representative sample of the Swiss population and found a minor and not significant effect of citizen investment and community acceptance. The respondents were asked to rate how much they accepted the project proposal of the hypothetical wind farm. The proposal consisted of attributes including amongst others the financial participation model, price and duration. In total they considered three different financial participation models, including citizen investment into a wind share and a wind bond. The authors found that all proposals were rated similarly, despite differences in the type of benefit through various financial participation models. They found minor but no significant increase in acceptance with either model.

Leer Jørgensen et al. [79] is the only paper which comments in detail on reasons for a strong negative association between citizen investment and community acceptance, at least for some of the local population. The authors conducted focus group interviews with Danish local residents and analyzed the perception of the property value-loss scheme, co-ownership scheme and the green scheme (community benefit scheme). The authors report that some residents raised concerns about distributive fairness. These residents expressed a sense of injustice and lack of trust in the developer. The claims are based on the criticism that developers were perceived to undertake only minimal efforts to involve residents through co-ownership. Furthermore, some residents stated their investment did not reflect their acceptance of the project, and one participant described their shares as "self insurance" (p.7) against the project.

Many studies report that fairness, trust and risk (or more specifically, citizens' perceptions of the extent of fairness, trustworthiness and risk) are common themes in the sampled papers when analyzing and interpreting the relationship between citizen investment and community acceptance. Of the sample in this study, only Warren and McFadyen [69]

and Tanujaya et al. [80] do not explicitly refer to these issues. The combined evidence suggests that factors which negatively influence the relationship between citizen investment and community acceptance include knowledge about citizen investment and its associated risks [76,77], lack of trust in the developer [70,71,74,76,77,79] and the perception of unfairness in relation to (1) the process [79] and (2) the sharing of benefits (and costs) [77].

5. Conclusion

5.1. Overall conclusion

This review notes that many of the conceptions of citizen investment are framed within the context of a just transition and have drawn on policy cases which were early to introduce citizen investment terms within the context of utility-scale wind energy deployment. The heightened policy attention on citizen investment has foregrounded the Danish and German cases, whose adoption of wind energy throughout the 1980s was galvanized by the role of citizen-led wind farm projects [83]. The papers reviewed within this study highlight uncertainty across other cases as to how best to define and structure the eligibility for citizen investment into wind farms. Auction-based approaches aim to deploy renewable energy capacity affordably and at scale and increasingly rely on commercial developers. This presents new questions as to the socioeconomic opportunities and challenges for citizens as actors within local energy transitions. Understanding the emerging mechanisms for citizen investment can help to progress SDGs 7 (renewable energy), 9 (innovation and infrastructure), 13 (climate action) and 16 (peace, justice and strong institutions). These principles are important for diversity, representation, and inclusion in further policy formulation towards net zero emissions.

This study offers a review of empirical papers which address the relationship between citizen investment into onshore wind farms and community acceptance. The results demonstrate that the issue of citizen investment is complex, given that the defined eligible 'community' could extend over potentially greater distances than the impacted residents in the vicinity of the project and the varied kind of investment models used.

The issue of investment into a wind farm by citizens living near the project (as well as communities of interest and developers from outside a given geographic area) have implications for the perceived distributional and procedural fairness, and thus on the acceptance of wind energy projects. Furthermore, this research notes that different types of citizen investment models are used in practice and that preferences of citizen investors differ between the analyzed studies. Local acceptance of citizen investment partly depends on the perceived risks of such investments. Citizen investments that formally structure the power of citizen investors through voting control have higher risks for shareholders, which highlights that there is a trade-off between the level of involvement and financial risk. Citizen investment models are therefore sometimes at odds with the needs of the community.

Simply offering citizen investments is likely not a singular instrument for the purpose of increasing acceptance. Studies which find citizen investment to be effective tend also to report a long process of self-empowerment within communities, active support of local politics and experience from past projects. The empirical evidence contrasted within this review illustrates factors such as trust, perceptions of fairness and risks, and experiences related to collective actions could influence the relationship between citizen investment and community acceptance.

5.2. Further research

This study shows that citizen investment into onshore wind farm development is an emerging but not yet well-established practice, which is illustrated by the fact that only 13 papers were suitable for the purpose of this study. The analysis shows the need for more empirical research on citizen investment models, which will become increasingly relevant in the near future due to an increase in policies that aim at promoting them. This study identifies several possibilities for further research.

First, as the papers in the study were all cross-sectional, longitudinal research effort should focus on different stages of the project development process (before and after planning, commissioning, and construction; or ex ante and ex post). Joining others [23,84], this study proposes that it is highly relevant to investigate how the perceptions of citizen investment models and relating variables change over time. This approach would apply Wolsink [85]'s U-shaped curve for the dynamic development of attitudes over project lifetime within this new context [86,87].

Second, there is some evidence to suggest that citizen investment models with voting rights for citizen control are not necessarily preferred to participation forms with less scope for citizen involvement (e.g., crowdfunding through debt investments and household benefits such as electricity discounts). This is perhaps surprising. In theory, citizen investments could facilitate greater procedural fairness because they give neighboring residents more say in a nearby wind farm. Focusing on why and when a higher level of participation (e.g., voting control) or more limited opportunities for participation (e.g., benefits and citizen investments without shared control) are desirable to nearby communities is a worthwhile future research topic. Mixed qualitative and quantitative approaches could helpfully contribute to a better understanding of how positive and negative perceptions evolve. This would strengthen theoretical explanations as to the circumstances in which citizen investment models with stronger/weaker scope for citizen involvement, control and voting opportunities are preferred, including the effects of trust, pride and a sense of ownership in projects.

Third, the paper identifies several opportunities to expand the choice of methodologies applied to citizen investments and community acceptance, finding several commonalities which have been investigated so far. Research has been approached through a combination of ex ante forecasting methods such as semi-structured interviews and experiments and ex post investigations including focus groups and community surveys concerning realized citizen investment schemes. Given the relative novelty of citizen investment mechanisms, the identified studies highlight a research gap associated with representative samples for a wider range of wind energy projects. As revealed preference datasets of realized citizen investment schemes become available over time, this topic invites examination.

Fourth, it would be interesting for future research to explore roles of citizen participation in the (co-) ownership of renewables across markets with different political and technological experiences and norms. Citizen involvement in decentralized renewable electricity depends on a country's priorities, capabilities, and preparedness, which are influenced by socio-cultural, technical, political, and economic particularities. This highlights the need for deeper research to further investigate the trade-offs between citizen participation mechanisms across different contexts. Such perspectives will contribute to a deeper understanding of the mechanisms through which it is possible to open participatory roles for citizens to benefit from the production of renewable energy [32,88,89]. Community involvement in decentralized renewable technologies can be important for the energy transitions across the global south. Lakhanpal [90] and Zárate-Toledo et al. [91] suggest that there are distinctions between the reasons for local opposition to wind farms in economies of the global north and the global south, which give greater focus to concerns of land access or displaced livelihoods. The promotion of citizen investment is one mechanism in which stakeholders might be included in the process of energy production. Considering this, the cases presented and analyzed in this review show that citizen investment opportunities are not a singular instrument for the purpose of increasing participation in local energy developments. Despite the potential contributions towards sustainable development, particularly SDG 16, citizen investment cannot be considered independently of other aspects of integrated decision-making and participation. Within this context,

further examination of the ways in which citizen investment mechanisms have been implemented in the context of renewable energy developments in emerging wind markets would be a valuable undertaking for future research.[1]

Fifth, the effects of climate change mean that political pressure to rapidly develop new wind farms will increase in many countries around the world. However, issues related to climate change are just one aspect of the energy policy trilemma that comprises of a) energy security, b) energy cost, and c) environmental outcomes. Climate and energy policies are sometimes at odds. For example, there is an increasing policy focus on promoting community engagement and participation in wind energy projects as conceptualized under policies such as the European Union's Recast Energy Directive. However, the simultaneous increasing adoption of policies like technology-neutral renewable energy auctions that aim to reduce the levelized cost of electricity are in some ways counterproductive to this aim [11,12]. Further research could elaborate how to connect efforts to build community participation in renewable energy production with other policy aims related to the energy transition. The increasing use of natural resources such as wind energy presents complex questions about the decentralization and polycentricity of human-made technologies and the optimal governance, management, and interdependencies between participating actors [88]. It would be valuable to give specific focus to the interactions which promote or constrain different outcomes for citizen investment and particularly the conditions that determine the flow of information and accordingly potential winners and losers. In this respect, actor-network theory has also been helpfully applied to examine the legitimacy, controversies and participatory dimensions of onshore wind energy [92,93]. Another approach which has been applied to citizen involvement in wind energy is the Socio-Ecological System framework [94], for instance to examine the strategic actions undertaken by citizen renewable energy cooperatives towards specific policy developments [95].

Sixth, the review process drew on a preliminary review and stakeholder inputs from a policy, industry and social research perspective. These inputs helped to inform the search terms, the design of appropriate inclusion/exclusion criteria, and the focus of analysis across multiple databases. Nevertheless, the empirical research papers covering citizen investment opportunities is not mutually comparable (i.e., the data are incomplete and non-systematic in aggregate). These assumptions could be enhanced in future research using policy analysis and thematic coding to define search terms to reduce the possibility of setting specific sources of error.

Finally, the investigation identifies studies which have a framework for citizen investment. This calls attention to the need for deeper research into other contexts where citizen investment takes place but which, for various reasons, are either not mentioned within the identified papers or whose scope does not meet the selection criteria of this study. Future research could also build on this research by giving specific focus to the additional cases. For such an endeavor, adjusting the specificity of the search criteria to include empirical studies which consider the acceptance of a wind farm by the community living beyond the immediate vicinity would be one approach to identifying alternative policy mechanisms.

Credit author statement

Jakob Knauf: Conceptualization, Methodology, Software, Formal analysis, Investigation, Validation, Writing – original draft, Writing – review & editing, Visualisation, Data curation. Julia le Maitre: Conceptualization, Software, Formal analysis, Investigation, Validation, Writing – original draft, Writing – review & editing, Visualisation.

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.

Data availability

No data was used for the research described in the article.

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Appendix A

[1] For example, the multi-million-euro Kouga, Tsitsikamma and Cookhouse utility wind farm projects in the Eastern Cape, South Africa, are joint-owned in partnership with local development trusts as a minority shareholder (16–25%).

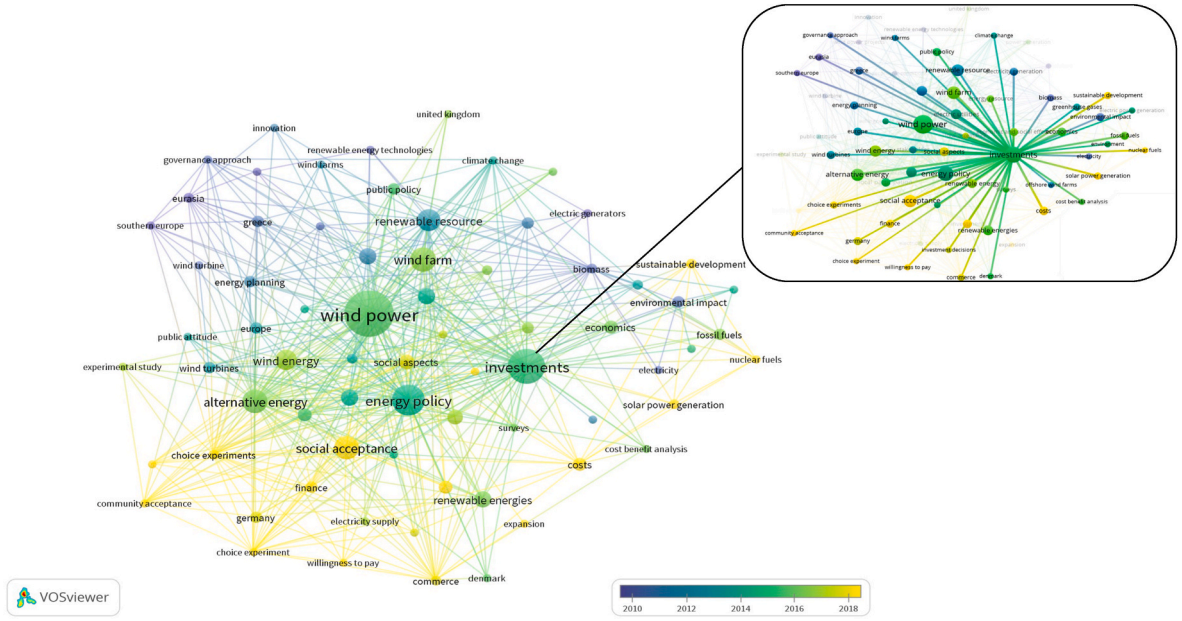

Fig. 1. Co-occurrence of 71 terms grouped into 5 clusters identified from 142 papers. Average publication year is shown on a scale blue - yellow, up to June 2022. Weight scales of bibliographic data nodes are based on occurrence by binary counts of author-supplied and indexing keywords and titles, and normalized for association strength, showing 500 links of co-occurrence between terms. Box shows links to "investments" term.

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