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Conceptualizing community in energy systems: A systematic review of 183 definitions

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ABSTRACT

Community-based energy systems are gaining traction among policymakers and practitioners as promising models for implementing a low-carbon energy transition. As a result, there has been a proliferation of concepts in the scientific literature, such as community energy, energy communities, community solar, and community wind. However, what scholars mean by "community" in these contexts is often unclear and inconsistent. This paper provides further conceptual clarity in the field by analyzing how the term of community is conceptualized in the scholarly literature on energy systems, through a systematic review of 405 articles. We combine an author keyword network analysis of this corpus with an in-depth analysis of 183 definitions extracted from these articles and systematically coded across three dimensions: meanings, activities and objectives of communities. Our findings show that the meanings attached to the notion of community and the alleged objectives pursued by communities vary substantially across concepts and over time. In particular, there has been a shift away from a notion of community understood as a process that emphasizes participatory aspects toward a notion of community primarily referring to a place. Furthermore, there is a growing focus on communities' economic objectives rather than their social or political goals. These findings suggest a weakening of scholars' attention to "transformative" notions of community emphasizing collective and grassroots processes of participation in energy transitions, to the benefit of "instrumental" notions. This trend runs the risk of placing the sole emphasis on the market value of communities, thereby diluting their distinctiveness from more commercial actors.

1. Introduction

The challenges of global warming and energy security require fundamental changes in energy systems. Besides controversial discussions regarding the mix of energy sources to be drawn upon in the future, the transition toward a decarbonized energy system has also prompted debates about how such a system should be configured. While many countries' energy systems have historically been characterized by large-scale and centralized extraction and conversion of energies [1–3], several non-governmental organizations [4–6] and scholars [7–11] have advocated for a smaller scale and more decentralized system.

Along with the development of more decentralized energy resources, there is a keen interest across energy social science in how far transitions to low-carbon energy are characterized not just by novel forms of technology deployment but also by sociopolitical changes that lead to collective benefit and empowerment in the form of more socially

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equitable energy production and distribution [12]. The roots of this discourse can be traced back to the 1970s, when the Alternative Technology movement advocated "soft energy paths" [13], comprising greater societal participation in energy systems drawing on renewable energy sources. Consequently, community control over energy technologies and infrastructures is increasingly seen as a means of democratizing energy systems and encouraging more active participation by citizens [6,14–16].

Accordingly, the terms "community energy" (CE) and "energy communities," as well as related concepts such as "community wind" and "community solar," have been gaining popularity among scholars for several years. At the European level, the introduction of the Clean Energy Package in November 2016 has resulted in a heavy push to recognize and define energy communities as legally encoded market participants with rights to trade, consume, produce, and more [17]. "Community" is an intrinsically polysemous and malleable term [18,19], and its recent popularity in the energy field has perpetuated the flexible usage of this word, as it has been used by stakeholders within different frames and discourses [20] and with diverse underlying interests. This conceptual ambiguity has been noted as a shortcoming of academic work on community energy: [21, p. 181] declared that "community energy has been an ambiguous term from the beginning," and [22, p. 188] asserted that "a common definition and understanding [of community energy] is not present so far. This is partly due to the lack of clear definition of the term community in the context of energy generation and elsewhere."

While the great diversity and flexibility in the usage of the term "community" have arguably worked in favor of its popularity [23], the fuzziness of this concept may exhaust its explanatory capacity. Further transparency regarding the prevalent meanings attached to this concept in academic discourses can help clarify and condense it, contributing to its analytical value. While several reviews on community energy and related concepts exist (see Table 1), these reviews often have a very specific focus [24,25]. focused on the concept of "community energy" while overlooking other concepts, such as "energy community," "community wind," or "community solar." In contrast, [26] focused on the concept of energy communities. The studies by Refs. [22,27], and [28] are primarily reviews of existing empirical evidence rather than conceptual work, focusing on the local impacts of community energy, the drivers of and barriers to community energy, and social innovation in community energy, respectively. [29] focused on the specific concept of integrated community energy systems, while [30] concentrated on peer-to-peer and community-based markets. Hence, to date, no reviews have systematically assessed the diverse meanings ascribed to "community" in energy systems. This paper aims to fill this gap by answering the following research question: How is the term of community conceptualized in the scholarly literature on energy systems?

Table 1
Previous reviews on community and energy.

#	Study	Number of reviewed articles	Conceptual focus
1	Berka and Creamer [27]	n.a.	Local impacts of community energy projects
2	Brummer [22]	62	Review of drivers of and barriers to community energy
3	Gjorgevski et al. [26]	n.a.	Energy communities
4	Hewitt et al. [28]	25	Empirical evidence of social innovation in community energy in Europe
5	Klein and Coffey [24]	76	Community energy
6	Koirala et al. [29]	1285	Integrated community energy systems
7	Sousa et al. [30]	80	Community-based and peer-to-peer markets
8	Van der Schoor and Scholtens [25]	263	Community energy

The remainder of this paper presents the theoretical background (Section 2), the methods used (Section 3), the results of the analysis conducted (Section 4) and their discussion (Section 5), and some concluding remarks (Section 6).

2. Literature

The extant literature indicates that the ambiguity in the use of "community" in energy systems stems from three main factors: 1) the meanings attached to "community", 2) the energy-related activities pursued by communities, and 3) the objectives pursued by communities. These meta-categories, which are elaborated upon in the following subsections, serve as a basis for structuring the search query for our data collection and defining the theoretical framework used in the analysis of our data (Section 2.2.)

2.1. Literature review

2.1.1. The diverse meanings of community

In the energy context, the term "community" has often been understood as a specific type of social relations characterized by participatory governance and distributive justice. [31], who explicitly introduced these aspects to the community energy discussion, identified two key dimensions, which reflect the views of those involved or concerned with community energy projects and respective policies, mapping the spectrum of social arrangements: a *process* dimension (who the project is set up and run *by*), referring to the involvement of a community of people in decision-making regarding a project; and an *outcome* dimension (who the project is *for*), referring to the social and spatial distribution of benefits. Community as a *process* suggests a distinctive way of acting characterized by a high degree of voluntary and collaborative involvement in energy projects by ordinary people [19]. Such a process emphasizes the quality of social relationships, characterized by high levels of social capital and interpersonal trust. From this perspective, community is also often seen as a third way, one that is distinct from both the state and the market [21,32]. In line with this, community as an *outcome* suggests that ideally, the benefits of a community energy project should be collectively shared among members of the local community. Since Walker and Devine-Wright's [31] seminal contribution, these two dimensions have often been identified as core attributes of the "ideal" community energy project [23,33,34].[1]

Alongside these views of community as a process and as an outcome, [19] stressed additional meanings that have been attached to community in a social sense: community as an *actor*, as a *network*, and as an *identity*. As an *actor*, the community is given agency (by its members or initiators) to take various actions and interact with others (e.g., local customers or public authorities). As a *network*, the community is formed by social relationships that can extend beyond specifically place-based networks, thus corresponding to the idea of a community of interest (e.g., stakeholders connected over virtual networks). When seen as an *identity*, the community concept refers to a group of people sharing the same values or ways of thinking and living. This model is consistent with earlier sociological and political accounts of community such as Taylor's [35, p. 26], for whom the first and most basic of the core characteristics of a community is that its members "have beliefs and values in common" [see also [36,37].

Community has also been understood as a construct characterizing spatial relations between people. In this perspective, one can distinguish between community as a *place* and as a *scale*. Conceived as *place*,

[1] Note that both dimensions are interrelated [18], as outcomes that are shared collectively require some sort of local process through which they are acquired and/or distributed.

community implies a set of social relationships embedded in a particular locality (e.g., a village or a town), in contrast to community as a *network*. The concept is thus defined by spatial proximity: People are bound together because of where they reside, work, visit, or otherwise spend a continuous portion of their time [38]. As a *scale*, community lies between the individual and household level as the lower bound and (typically) the level of local government as the upper bound. Hence, it sits on a medium level within a hierarchy of interacting scales of action.

The literature also reveals that for some authors (mostly engineering scholars), the relationship between community members is primarily of a technical nature: they share energy resources with each other. Here, the emphasis is placed on the material connection between actors as embodied by an infrastructure, such as a microgrid or a network, and much less on the social dimension of the community. A typical example of a community primarily understood as a set of entities interlinked by technology is the definition of an energy community "as a group of consumers and/or prosumers, that together share energy generation units and electricity storage" [39].

A distinction is made in the literature between "community energy" and "energy community." While community energy has been extensively studied in the academic literature for over a decade, the concept of energy community has gained more traction with the introduction of the "Clean Energy for All Europeans" legislative package in 2016. In the final versions of the directives, the EU legislators defined two distinct new concepts: "renewable energy communities" (recast Renewable Energy Directive, RED II, Art. 2 No. 11) and "citizen energy communities" (Electricity Directive, Art. 2 No. 11). According to the legal definitions, renewable energy communities (RECs) almost form a sub-set of citizen energy communities (CECs). [40, p. 2] suggested that "energy communities," in contrast to "community energy," is a concept that "more specifically defines the relationship of communities with their intended energy management." Still, the two concepts are most often used interchangeably, although with a slightly different emphasis, as the distinction made by Ref. [40] indicates.

2.1.2. The diverse meanings of energy

"Community" has been used to describe a multitude of energy-related activities generally characterized by their small-scale or decentralized nature. These range from supply-side activities, such as energy generation and distribution [41], to demand-side activities, including energy use, energy efficiency measures, and information and dissemination [42,43]. When generating energy, community-based energy projects rely on a variety of (predominantly renewable) energy sources. To specify the latter, some authors have used expressions that make these sources explicit. Hence, "community wind" [44–46] or "community solar" [47] are expressions that frequently appear.

More recently, the term "community" has increasingly been used to reflect the more active role of the demand side in implementing "smart" and flexible energy technologies and practices that address the loss of grid stability associated with the rise of distributed intermittent renewable energy sources. Accordingly, the potential of communities has been highlighted in terms of promoting integration [48], aggregation [49], and control [50] of distributed energy resources for demand response management [51] and electricity trading at the local level [30]. These new roles for communities have been translated into new concepts, including "community energy storage" [52], "community energy network," "community microgrid" [53], "community energy internet" [54], and "community energy markets" [30,55]. These concepts differ from more generic notions of community in that they often refer to specific technologies or infrastructures. For instance, Ref. [56, p. 1] define integrated community energy systems as "a collection of distributed energy resources … supported by demand-side management and storage that are managed at a community level to generate and satisfy the local energy needs." Similarly, [52] define community energy storage as energy storage "located at the consumption level which can perform several applications with a positive impact for both end users and the network."

2.1.3. Objectives pursued by communities

Our preliminary review of the extant literature indicates a great diversity of objectives intentionally pursued by communities. According to Ref. [24, p. 877], this diversity can be linked to "a variety of member types and organizational structures, multi-faceted approaches to action, and a wide range of strategies and technologies." A survey of community energy projects conducted in the UK [23] shows that their goals fall into five broad categories: economic, environmental, social, political, and infrastructural. According to this survey, economic goals (e.g., saving money on energy bills) were the most commonly cited objectives. This notion was echoed by Ref. [24, p. 877], who noted that the goals pursued by communities are "often unrelated to energy and climate change." Ranked by importance, economic motives are followed by environmental (e.g., reducing carbon dioxide emissions), social (e.g., improving social cohesion), political (e.g., community empowerment), and infrastructural (e.g., improving energy independence) goals [25, p. 981]. These findings are also broadly in line with studies on community members' motivations for joining and participating in such initiatives, which have highlighted economic, social, and environmental drivers, occasionally in different orders of priority [57–60].

It is also important to distinguish communities' proclaimed goals from their outcomes. Indeed, the latter need not overlap with the former. As [18, p. 3] stated, "the means of [community renewable energy] are not only productive of the intended ends, but the processes that exist on the ground produce or foreclose different outcomes." As examples of this scenario, [61], studying communities in Feldheim (Germany) and Samsø (Denmark), found that the primary motivations for initiating community renewable energy projects in both cases were social cohesiveness and local economic development, while positive contributions to broader environmental causes, such as climate change mitigation or the phasing-out of fossil fuels, were considered beneficial side-effects.

In summary, while there is a great deal of ambiguity in the literature on energy systems concerning the use of the word "community," our preliminary overview identifies key concepts around which the literature is structured regarding the meanings attached to community, energy-related community activities, and the objectives pursued by communities. In the following subsections, these differentiations are analyzed further with regard to their variation across different concepts and over time.

2.2. Theoretical framework

This subsection presents the theoretical framework developed to code the definitions collected for this paper based on the literature outlined in Subsection 2.1. The framework (see Table 2) was developed based on the three dimensions identified in the literature as the main sources of ambiguity: meanings of community, energy activities of communities, and objectives pursued by communities. The meanings of community were derived from Walker's [19] classification of meanings attached to community in environmental and carbon-related contexts, which includes six dimensions: community as a process, as an actor, as a network, as an identity, as a place, and as a scale. The outcome dimension was added to this typology, as it has been emphasized as a key dimension in the community energy literature. Community as a *technology* was inductively added to account for definitions that conceive communities in terms of sharing technological devices that materially connect members. Regarding the activities of communities, we distinguish between supply-side activities, covering aspects such as electricity and heat generation; demand-side activities, including, for example, energy efficiency and conservation; and integrated supply-and-demand-side activities.

Regarding the objectives pursued by communities, we partly rely on Seyfang's et al. [23] categories and distinguish between economic,

Table 2
Theoretical framework. Source: Authors.

Dimensions	Sub-dimensions	Description	Keywords
Meanings of community	Outcome	Collective distribution of costs and benefits	Owned; ownership; distribution of costs and benefits
	Process	Voluntary and collaborative involvement of ordinary people in setting up and running projects	Owned; ownership; managed; governed; run; participation; controlled
	Identity	Sharing of beliefs and values or ways of thinking and living	Shared values; identity; common beliefs; place identity; place attachment
	Actor	Explicitly named individuals, groups or organizations that comprise the desired "community"	Citizens; SMEs; government;
	Network	Networks and social relationships that extend beyond specifically place-based networks (e.g., virtual communities)	Common interest; community of interest
	Place	Geographical proximity of members	Spatial proximity; closeness; local; neighboring; community of place
	Scale	Intermediate level within a hierarchy of interacting scales of space (exceeds individual household level)	Small-scale; community level; distributed; decentralized; regional; urban
	Technology	Sharing of a technological device that materially connects members	Integrated; local grid; local network; local energy system; shared storage; prosumer
Energy activities of communities	Supply-side	Production, transmission, and distribution of energy (electricity, heat, etc.)	Electricity generation; heat production; generation
	Demand-side	Use of energy (energy efficiency, electric mobility, storage, demand-side management, etc.)	Energy efficiency; energy use; energy consumption; energy storage; consumption behaviors
	Integrated supply and demand-side	Integrated management of supply and demand to optimize energy use (e.g., microgrid)	Microgrid; energy management; integration
Objectives pursued by communities	Economic	Aims at financial or economic benefit for members of the community	Returns; financial benefit; economic advantage
	Social	Aims at social aspects in the community	Social capital; social cohesion; social ties; community building
	Environmental	Aims at climate and environment protection	Low carbon; emission reduction; renewable energy; ecological; environment; climate
	Energy autonomy	Aims at partial or full independence from the national energy supply system	Energy independence; fossil fuel independence; resilience
	Political	Aims at altering existing power relations and inequalities within energy systems	Empowerment; self-determination; political autonomy; co-determination; participation
	Infrastructural	Aims at improving the reliability of energy supply infrastructure	Grid balance; grid integration; integrated; energy management

environmental, social, political, and infrastructural objectives. However, unlike these authors, we consider energy autonomy as an objective in its own right. Striving to become partly or fully independent of centralized energy supply infrastructures may, at times, be driven by political motives (in the sense of, for example, altering power relations in existing energy systems; [62]) or a (perceived) need to alleviate pressure on existing infrastructures (such as electricity grids, some of which are not built to address the fluctuating power generation often associated with renewable sources of energy) by consuming energy close to where it is produced. However, some quests for energy autonomy are motivated by objectives of neither a political nor infrastructural nature (e.g., off-grid islands and remote areas merely aiming to set up or improve their energy supply). Only the objectives intentionally pursued by communities were considered. The third column in Table 2 presents examples of keywords that are typically attached to a specific meaning.

3. Methods

A popular method used in the literature to investigate an idea is to gather and analyze written definitions of the concept in question [63,64]. However, many scientific publications do not present explicit definitions of the terms they employ. This may be due to space restrictions or because authors find a concept so self-evident that they choose not to include a definition. Even when a definition is presented, the understanding of a concept may be broader than the written definition. Indeed, authors often choose to present an abridged definition of a complex concept that focuses solely on the aspects investigated in a particular paper due to these space restrictions.

To address these limitations, in this paper, we combined two analytical methods to gain further insight into how scholars have employed the concepts of community (see Fig. 1). First, we analyzed two bibliometric indicators often used to identify the implicit academic associations between concepts [65,66]. Since the associations are implicit, the sample is considered as a whole—that is, it includes articles that offer a definition and those that do not. The indicators include the following:

I. The co-occurrence of concepts—that is, the frequency of their concurrent use in the title or abstract as an indication of their level of mutual association.
II. The co-occurrence of keywords and concepts as an indication of their associated meaning in the literature.

Second, for disclosing the more explicit associations, we analyzed definitions, focusing only on the articles that include a definition of one of the concepts. The remainder of this section provides further details on the methodical process followed.

3.1. Sample selection

As noted in Subsection 2.1, we observed that community-related concepts in energy studies are consistently worded as various combinations of two components: the term "community" and an energy source, such as "energy," "solar," or "wind." We therefore included these two components in our search. Regarding the term "community," we included both its singular and plural form (i.e., "community" and "communities"), as both forms are used in the literature. As energy sources, we considered "wind" and "solar" in our analysis, as these are the most widespread energy sources insofar as the development of small-scale renewable energy projects is concerned. We also included "renewable energy" and "energy" as generic terms.

We relied on Scopus, because this database provides the fullest account of articles, with no dependency on International Scientific Indexing (ISI) indicators that leave potential holes in the database for certain outlets and years [67]. The search was restricted to material published in English up to and including 2019. No start date was chosen,

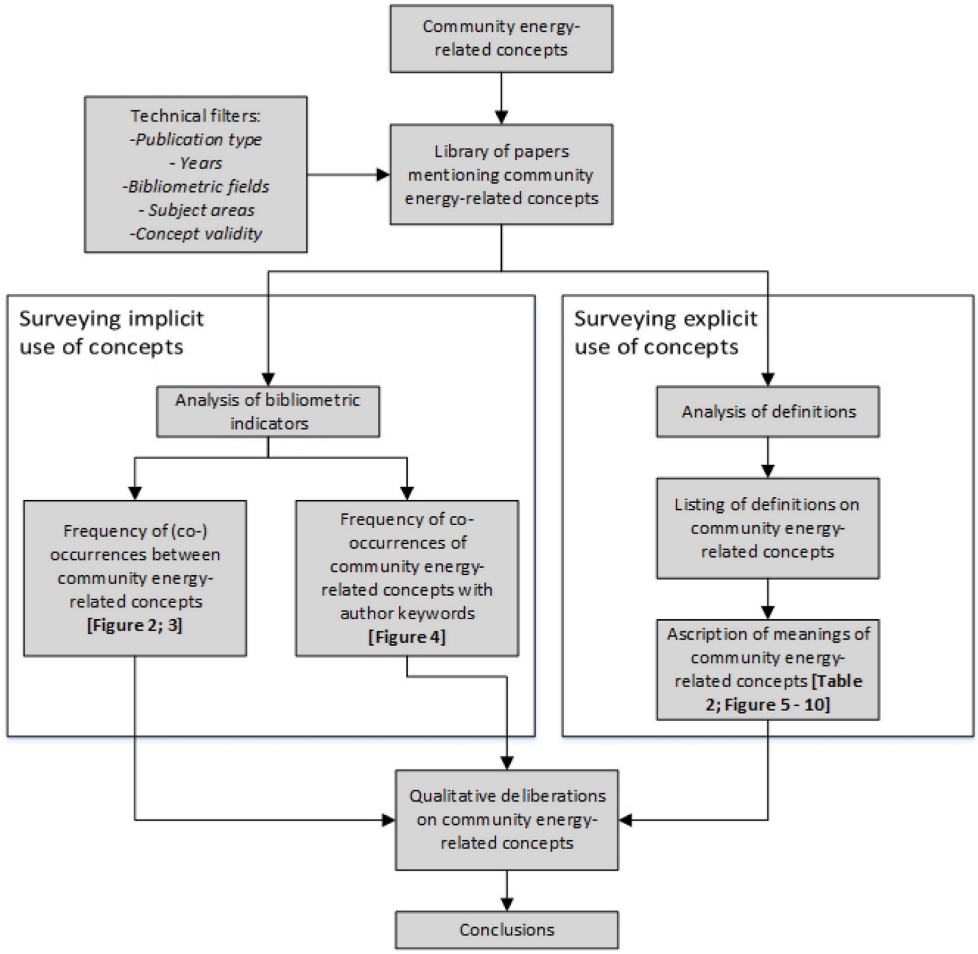

Fig. 1. Research design. Source: Authors.

enabling us to collect all possible publications. 2019 was chosen as the final year, as this was the most recent year in which a complete publication list was available at the time of the analysis. In addition, we searched for articles that featured any of these concepts in their titles or abstracts, as we assumed that the inclusion of these terms in either the title or the abstract of a study would indicate that the study in question would focus on at least one of the concepts of interest.

As "community" is used in various ways, we employed search criteria in which this term could function as either an adjective or a noun. From a bibliometric standpoint, an efficient way to search for these bi-directional combinations of terms is to use the "W/0" Boolean operator in Scopus (i.e., performing a bi-directional search for two phrases with no words in between). However, the "W/0" has the disadvantage of being insensitive to interpunctions between the terms (e.g., commas or semicolons). Thus, we focused on in-text searches to obtain interpretable and meaningful contexts of word use and excluded the author keywords, which have numerous semicolons between words. Title and abstract offer in-text analysis, as the concepts are part of sentence structures. A final key scoping was performed to focus on subject areas related to energy systems and community as a social phenomenon. The following search query was used to capture the full account of all the relevant bibliometric parameters and preserve reproducibility while minimizing the number of non-related articles in the corpus:

TITLE-ABS ("renewable energy" OR "energy" OR "wind" OR "solar") W/0 TITLE-ABS ("communit*") AND DOCTYPE (ar OR re) AND PUBYEAR <2020 AND (SUBJAREA (soci) OR SUBJAREA (ener)).

This search resulted in a database of 579 articles. We then manually checked the relevance of all the papers. Two types of articles were identified as irrelevant to our research interest and were discarded because they used the term "community" with a different meaning entirely: papers referring to community as a European institution (e.g., the European Energy Community) and papers referring to community as a specialized professional group (e.g., the atomic energy community). This resulted in a final sample of 405 papers. This corpus does not necessarily represent the complete set of all thematically relevant articles, and results thus need to be interpreted with caution—see, for example, Wolsink's critique of bibliometrics [68]. However, it was developed through an iterative process of refining the query and cross-checking results and can thus be seen as the best approximation of the full set, validating the relevance of the articles in the dataset to the topic of community in energy systems.

3.2. Co-occurrence and keyword analysis

First, to establish the prevalence of the searched terms, the frequency with which they occurred in titles and abstracts over time was determined. Second, the analysis focused on the mutual connections between concepts. This was achieved by measuring their co-occurrence—that is, where two or more concepts are used concurrently in the title or abstract of a study. Identifying instances in which concepts were used in conjunction with other concepts enabled us to establish relationships among the concepts, which could then be visualized through a co-occurrence network (see Fig. 2). The higher the number of co-occurrences, the more central the position of a given concept within the network.

3.3. Analysis of definitions

3.3.1. Construction of the database

Every document identified in the first stage was manually reviewed based on whether it offers a definition of one of the concepts. For the present study, the term “definition” was understood as “a statement of the meaning of a word or word group” (adapted from Merriam-Webster, 2018). In total, 183 definitions were compiled. Identified definitions were extracted from their original sources and cataloged within a common inventory, which also included basic metadata for further analysis. The metadata included author, title, journal, publication date, abstract, author keywords, and specific concept (e.g., “community renewable energy” or “energy community”). To ensure the reliability of the extraction process, only sentences in which authors explicitly aimed at defining one of the concepts (e.g., “community energy is (…),” “community energy is defined as (…),” “the notion of an energy community seeks to (…)”) were taken into account. Neighboring text was not considered. An overview of all 183 definitions is provided in the supplementary materials for this article.

3.3.2. Data analysis

First, each definition was attached to a specific concept, based on the specific terms that appeared in the title and/or abstract of the study in question. Our search process led us to consider the following concepts in the analysis: “community energy,” “energy community/ies,” “community renewable energy,” “renewable energy community/ies,” “community wind,” “wind community/ies,” “community solar,” and “solar community/ies.” In addition, we considered the concepts “integrated community energy systems,” “community energy storage,” and “community energy network” as a separate category (which we called “ICES/CES/CEN”), because, unlike the other concepts, they refer to specific technologies or infrastructures, as noted in Section 2.1, and are thus expected to have different meanings.

Next, the definitions collected were carefully examined and manually coded using the coding framework (see Table 2), following an initial set of coding rules. The coding procedure allowed a multiplicity of meanings to be attached to the definitions (that is, dimensions were not mutually exclusive), as it was common for one definition to cover several meanings. To ensure the validity and reliability of the research design, we relied on a double-blind procedure. Thus, the definitions were coded by two authors who coded the full sample independently and then compared and discussed diverging results. To allow for inductive modifications of the coding framework (which was deductively derived from the literature), the coding rules were reconsidered on the basis of inter-coder deviations and, in some cases, specified. This is acknowledged as good practice to enhance reliability in manual coding [69,70]. An overview of all coding tables is provided in the supplementary materials for this article.

As a next step, we computed the relative frequencies of the codes (i.e., the ratio between the counts of a specific code to the total number of definitions) to examine the relative usage of the different meanings assigned to “community”, the communities’ energy-related activities and their objectives within the definitions. These relative frequencies were then compared across concepts to illuminate the associations between concepts and meanings. The counts of our codes were also analyzed over time to examine the temporal evolution of meanings and other coded dimensions.

4. Results

4.1. Co-occurrence and keyword analysis

When analyzing the relations among the eight concepts through the number of co-occurrences between them (Fig. 2), it becomes evident that the concepts have different levels of significance in the academic literature. “Community energy” is the concept that appeared most frequently, followed by “energy community,” “community renewable energy,” and “community solar.” “Community energy” is not only the most common category, but also the most centrally placed in the network, with direct connections to four other concepts. “Energy community” and “community renewable energy” are also quite central, as they are connected to three other concepts. “Community renewable energy” and “community energy” are most strongly connected with each other, suggesting that they are conceptually close. “Renewable energy community” co-occurs with other concepts in a few cases only, while “wind community” and “solar community” do not co-occur at all with any of the other concepts. This suggests that these concepts are either of lesser importance or constitute their own independent conceptual spheres.

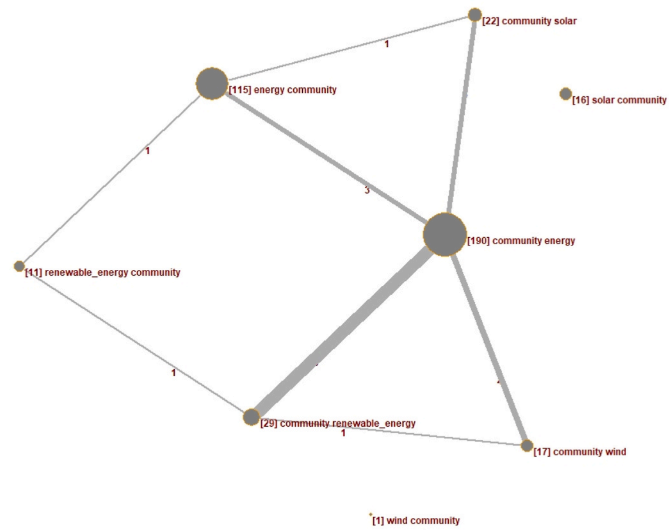

Fig. 2. Co-occurrence between concepts. Source: Authors. Note: The numbers indicated next to the nodes represent the number of articles retrieved that mentioned a particular concept, while the numbers next to the lines represent the number of articles mentioning both of the connected concepts in their title or abstract. For example, 190 articles feature “community energy” in either the title or the abstract, while three articles mention “community energy” and “energy community” together.

The evolution of the use of the eight concepts over time (as measured by the annual number of publications employing them; Fig. 3) shows that the popularity of the term “community energy” has grown significantly since 2014 and, despite a decline in the number of outputs in 2019, is still by far the dominant concept in the literature. The use of the term “energy community” increased from 2017 onwards, a trend linked to the European Commission’s adoption of the Clean Energy Package in 2016, which has likely boosted the use of said notion. The package formally recognizes the role of energy communities in Europe’s energy transition by introducing and defining the notions of “renewable energy community” and “citizen energy community” [17]. The term “community solar” has recently become more popular, reflecting the increasing interest in this model for promoting solar energy in different regions of the world, including Europe, Asia, and the USA [71,72]. The term “community renewable energy” has been growing and stabilizing within the last five years.

Fig. 4 shows the non-incidental co-occurring author keywords for seven concepts (single co-occurrences and the concept of “wind community” excluded). Of the seven concepts, community energy and energy community have the most distinct associations. Community energy is clearly linked with several keywords denoting processes of citizen or grassroots participation, thereby reflecting the meaning of community as “process”: “citizen participation,” “civil society,” “energy democracy,” “community participation,” “social movements,” and “grassroots innovation.” “Energy community” is associated with EU

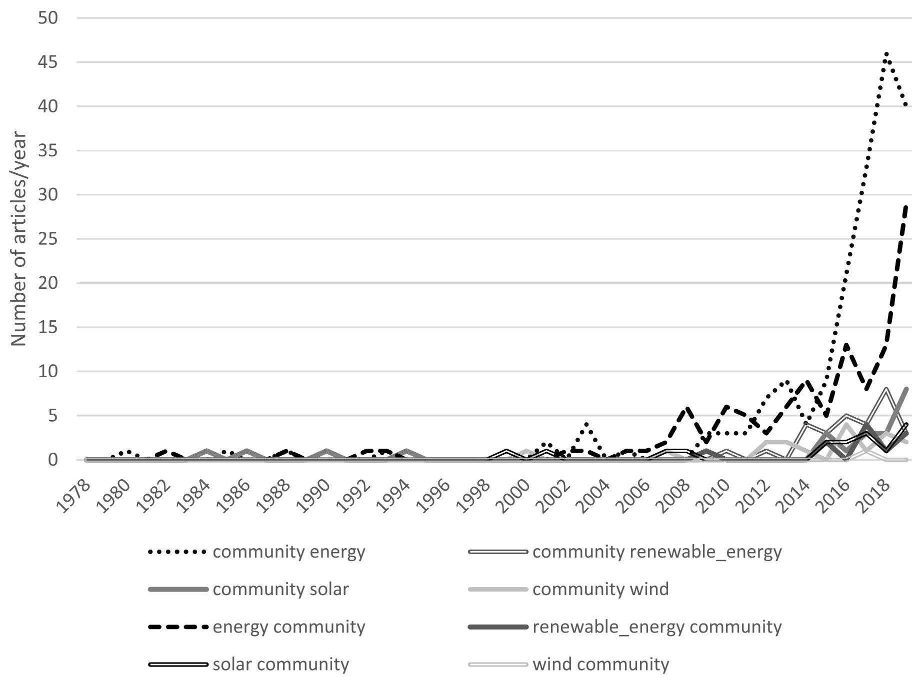

Fig. 3. Trendline of the concepts. Source: Authors.

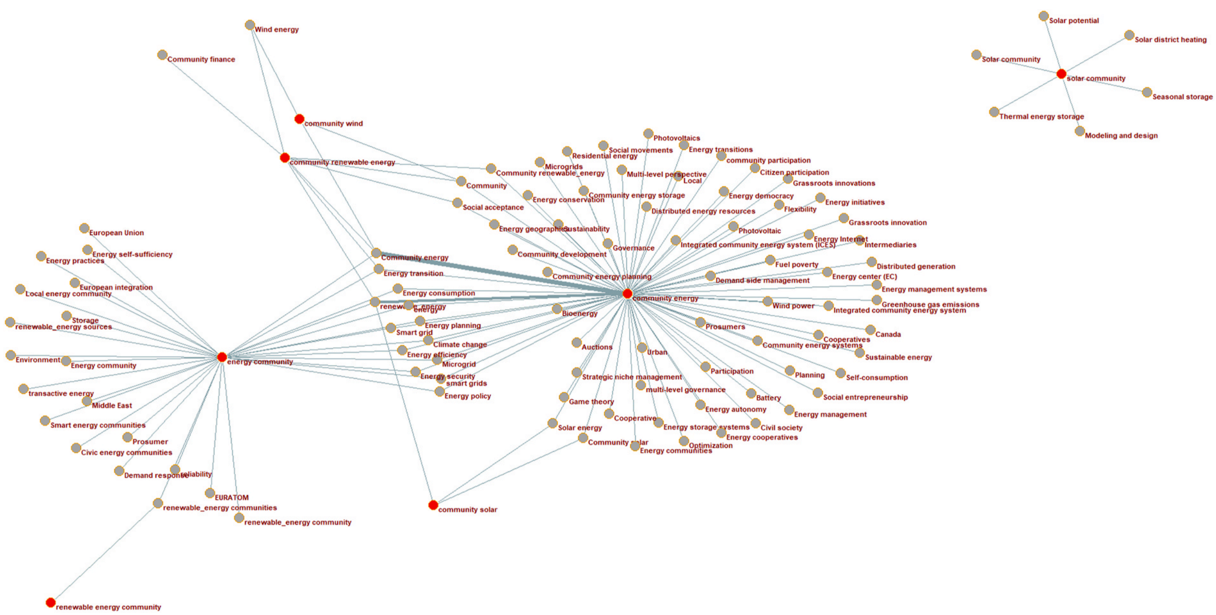

Fig. 4. Co-occurrence of keywords and concepts. Source: Authors.

policy, with relevant keywords including "European Union" and "European integration." This reflects the inclusion of this concept within the European Commission's Clean Energy Package. It is also associated with ambitions for renewable energy sources and their economic implications from energy users when acting in that system, like "demand response," "transactive energy," and "prosumers."

Both community energy and energy community show the strongest interlinkages through the author keywords. The connection between these two concepts demonstrates their shared focus on global ambitions for fundamental change ("energy transition," "climate change") in the energy system ("energy consumption," "energy security," "energy policy") with the help of technical solutions ("smart grid," "microgrid"). It is notable that solar community constitutes an independent conceptual island, being linked to keywords that reflect solar energy technological solutions such as "seasonal storage," "solar district heating," and "thermal energy storage."

4.2. Analysis of definitions

4.2.1. Meanings ascribed to community in the literature on energy systems

When looking at the sample as a whole, our results show that the foremost meaning ascribed to community in the literature is community as a "place" (mentioned in 62% of the definitions; see Fig. 5). Accordingly, a majority of definitions emphasize that in order to qualify as having a community nature, a project should be "conceived, carried out, and implemented by people who are [...] *located close to or in the exact*

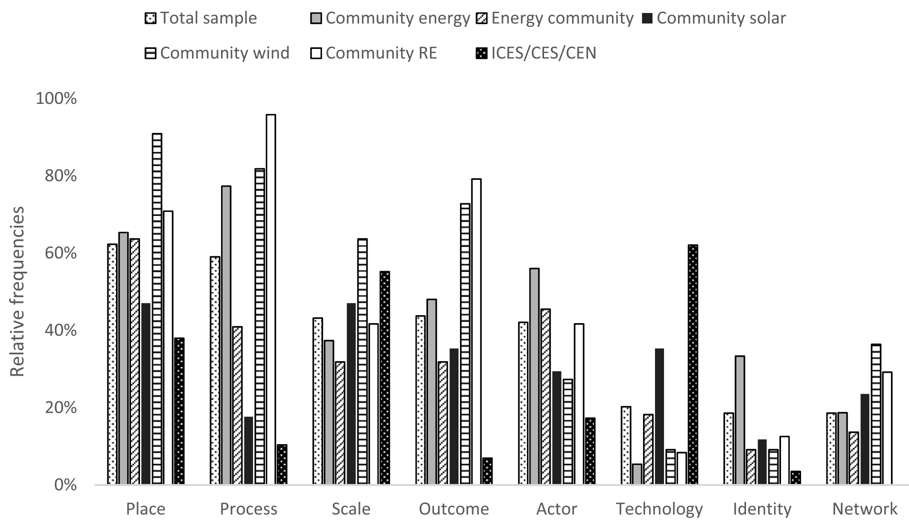

Fig. 5. Ascription of meanings by concept. Source: Authors. Note: Results for "solar community," "wind community," and "renewable energy community" are not included in the figure, as they are found much less frequently in the literature than the other concepts.

place of the project" [73, p. 3]. There are also notable differences between concepts. Community as a "place" is especially prominent for community wind. For example, Bolinger's [44, p. 556] often-cited definition of community wind emphasizes the financial participation of local community members: "locally owned, utility-scale wind development that is interconnected to the grid on either the customer or utility side of the meter." In this case, "locally owned" means that one or more members of the local community have a significant direct financial stake in the project. As wind farms have generated controversies in local communities across the world [74], the prominence of the "place" dimension in the community wind literature may be related to its frequent emphasis on the actual or potential benefits of local ownership in terms of local acceptance of wind farms [75,76].

It is insightful to contextualize these findings with the observed occurrence of community as a "network," as this conceptual category usually refers to a more geographically dispersed community and is often defined in contrast to place-based, geographically bounded communities [77]. Notably, community is more frequently understood as a "place" than as a "network" (62% and 18% of definitions, respectively). Thus, while community often refers to both place and interest, a localist, place-based notion dominates in the literature. This concurs with the self-assessment of initiatives on the ground [78]. For example, [23] showed that nine out of 10 community energy initiatives in the United Kingdom perceived themselves as local "communities of place."

Again, looking at the overall sample, the "process" dimension is the second most frequently observed meaning ascribed to community (58% of the definitions). However, there are considerable differences between concepts. "Process" is particularly prominent for the concepts of "community renewable energy" and "community energy" (96% and 84% of the definitions, respectively), possibly because it was introduced as a central feature of community (renewable) energy projects early on [31]. This is also in line with the finding highlighted in the author keyword analysis that "community energy" is more strongly connected to keywords denoting processes of civic or citizen participation than "energy community" or other concepts. The "process" dimension is also prominent for community wind (90% of the definitions). As for community as a "place," this emphasis is often related to social acceptance of wind farms. In contrast, the "process" dimension is much less frequently mentioned for community solar, suggesting that it plays a minor role with regard to solar energy. The same observation is true for ICES/CES/CEN.

Community as "scale" comes in third position, with 43% of the definitions understanding the term community as referring to the (regional) level that energy systems operate on, and their (spatial) latitude. The community scale essentially translates to an intermediate position at the "meso" level—that is, between decentralized energy technologies at the "micro" level (such as private households' rooftop solar) and large power plants (as incremental elements of traditional centralized energy systems) at the "macro" level. For instance, according to Ref. [79, p. 534], community energy projects "are likely to be small: projects are often at the meso-level, smaller than technologies that are generally associated with a centralized energy system, but larger than a single household/building." The notion of community as a scale is prominently linked to the concept of community wind. For example [46, p. 442] emphasizes that "community wind tends to be at smaller scale than conventional wind companies." This, again, may be related to the issue of social acceptance of wind energy, as the height of turbines and the size of wind parks have been identified as crucial determinants of their local acceptance [80,81]. Community as a scale is also quite strongly attached to the concepts of ICES/CES/CEN, reflecting the capacity of these concepts to foster the development of small-scale energy resources.

Sharing the third rank with "scale" is the understanding of community as an "outcome" (43% of the definitions). This meaning is particularly associated with community wind and community renewable energy. In the case of community wind, the outcome dimension often refers to the financial compensation offered by wind energy developers to communities, as indicated by the following quotation: "Small financial benefits are sometimes given to local communities, but this depends on the developer. There is an increasing move to encourage members of the public to buy equity shares in wind farms" [82, p. 300]. Similar to the process dimension, the prominence of community as an outcome for community renewable energy may be explained by the broad appreciation of this dimension as a central feature of community (renewable) energy projects, dating back to at least when Walker and Devine-Wright [31] published their seminal work. In contrast, this meaning is marginal in the literature on ICES/CES/CEN.

Community as an "actor" comes in fourth position (42% of the definitions). Here, community refers to specific agents—individuals, groups, and organizations—that constitute communities. This meaning particularly stands out for the concept of community energy, which may be explained by the stronger anchorage of this concept in the energy social sciences. The actors most frequently mentioned are citizens, local public authorities such as municipalities, and specific organizational bodies, such as cooperatives or social enterprises [83]. For example [84, p. 1176] defined renewable energy communities as "characterized by groups of citizens, social entrepreneurs, public authorities and community organizations participating in the energy transition by jointly investing in, producing, selling, distributing and consuming renewable energy."

Within the order of meanings ascribed to community by frequency, community as "technology" comes next (21% of the definitions). The relatively low occurrence of this meaning may be due to the historical roots of the term "community" in the social sciences, while community as technology is more common in engineering sciences and relates to the combination of producing, consuming, and managing energy as well as the technical interconnection between community members. The meaning of community as technology is most strongly related to ICES/CES/CEN (72% of the definitions). This is to be expected, since these concepts usually refer to specific technologies or infrastructures, as noted in Subsection 2.1. Community as technology is also strongly related to community solar (38% of the definitions), likely because community solar usually refers to a specific technology. For example [72], p. 10] stated that community solar projects "connect subscribers to the array via a local distribution circuit even if a portion of a subscriber's total electrical budget is derived from grid-connected sources." To a lesser extent, community as technology is also related to the concept of energy community. For example [85, p. 1], who present a mathematical framework for modeling loss allocations in so-called transactive energy markets (such as "peer-to-peer" contracts and "energy communities"), defined energy communities as "*groups* of local consumers and prosumers that produce, consume and share resources in a joint fashion."

Finally, "identity" is the second least frequently mentioned meaning attached to community in our sample, just above "network," with only 19% of the definitions mentioning it. This is surprising, as shared identity and values have often been reported as constitutive elements of community in sociological and political studies [36,86]. Community as identity is most prominently attached to the concept of community energy (38% of the definitions), again reflecting the anchorage of this concept in the social sciences. An example of community as "identity" is provided by Ref. [87, p. 748], for whom "the regional identity and a sense of belonging are important prerequisites and/or consequences of community energy projects … This identity also results in a 'community spirit.'"

Considering the evolution of meanings ascribed to community over time (as measured by the annual number of definitions included in articles which mention a specific dimension; see Fig. 6), it can be noted that from 2013 to 2017, community was most frequently understood as a "process," closely followed by "place" and "outcome." Since 2018, however, the notion of community as a "place" has gained significant momentum, becoming by far the most frequently ascribed meaning in the literature . This trend suggests that the "process" dimension of community, which has been a major aspect in the literature for a long time, has gradually lost importance relative to "place." The notion of community as "actor" has also been growing significantly since 2017, eventually outpacing "process" in 2019. Understandings of community as "network" and "identity" have also increased recently, although at more modest rates. Community as "scale" was growing until 2018 but declined in 2019.

4.2.2. Energy activities of communities

When examining the activities of communities along the energy value chain (see Fig. 7), we found a supply-side dominance for all concepts except ICES/CES/CEN, with over 63% of the definitions mentioning supply-side activities compared to 31% including demand-side activities. This possibly reflects how, traditionally, renewable energy generation has been the primary focus of many community-based energy initiatives across several countries [e.g. 28,87]. Indeed, for many years, this business model has been supported by policy mechanisms such as feed-in tariffs (e.g., in Germany and Denmark). Only recently have community-based energy initiatives diversified their revenue streams by including other activities on top of renewable energy generation, including electric mobility services, energy efficiency models, and demand-side management [22]. Amidst the different concepts, community solar and community wind are particularly focused on the supply-side. This is not surprising, as they both refer to specific sources for renewable energy generation. The integration of supply- and demand-side is mentioned by 20% of the definitions. Here, ICES/CES/CEN stand out as concepts strongly focused on these types of activity, with 74% of the definitions mentioning them. This reflects the role that scholars ascribe to these technologies for the integrated management and optimization of energy production and use. In 19% of definitions, the energy-related activities were not specified.

Fig. 8 shows the evolution of the activities of communities mentioned in the definitions. It reveals that the mentions of supply-side activities have grown sharply since 2011, confirming the early focus of the literature on supply-side activities. The allusions to demand-side activities have also increased since that year, but at a more moderate pace, while the integration of supply- and demand-side activities has grown since 2014. This reflects the aforementioned trend toward diversification of communities' business models and the recent scholarly interest in community-based integrated energy systems and related technologies.

4.2.3. Objectives pursued by communities

Among the definitions that explicitly mention at least one objective pursued by communities (about two-thirds of the sample; see Fig. 9), environmental objectives are most frequently referenced (35% of the definitions). By far the most mentioned environmental objective is carbon emission reductions through community-based projects. Other, more specific environmental objectives are cited, including the promotion of low-carbon lifestyles: "some community energy projects are also established to encourage demand reduction, facilitate tariff negotiation, behavior change, or some mix of these" [40]. This primacy of environmental goals contrasts with some empirical studies [23,61], showing that community energy projects primarily prioritize the cohesiveness and interests of the community (i.e., economic development) rather than the commitment to global sustainability discourses (i.e., climate change). This discrepancy between definitions in the literature and empirical data may indicate confusion within the academic discourse between the intended goals of communities and their observed outcomes. Furthermore, these deviations could reflect normative assumptions on the nature of respective projects made by scholars, which are only limitedly in line with the empirical reality.

Economic objectives are the second most frequently mentioned goal, present in 29% of the definitions. However, there are large variations between concepts. Economic objectives are particularly strongly related to community wind (50% of the definitions) and ICES/CES/CEN (44%) and, to a lesser extent, community solar (38%) and energy community (36%). In contrast, they are associated less with community energy and community renewable energy (about 22% and 21% of the definitions, respectively). Definitions of ICES/CES/CEN often suggest that the adoption of these technologies or infrastructures will be economically beneficial for community members. For example [88, p. 358] noted that "CES will offer distributed applications and energy trading in electricity markets more efficiently." Economic objectives are also especially prominent in relation to the concept of community solar, suggesting that the economic benefits brought to community members by such projects are particularly valued. For instance Ref. [89], stated that a community solar project pools "investments from multiple members of a community and provides power and/or financial benefits in return." To some extent, this also holds for the definitions of energy community. For example, according to Ref. [39, p. 2], the rationale of an energy community "is that it is financially beneficial to exchange energy within this community, rather that exchanging it with the grid."

Political objectives are the third most frequently mentioned goal, accounting for 16% of the definitions. They encompass aspects such as promoting self-determination and empowerment of local communities.

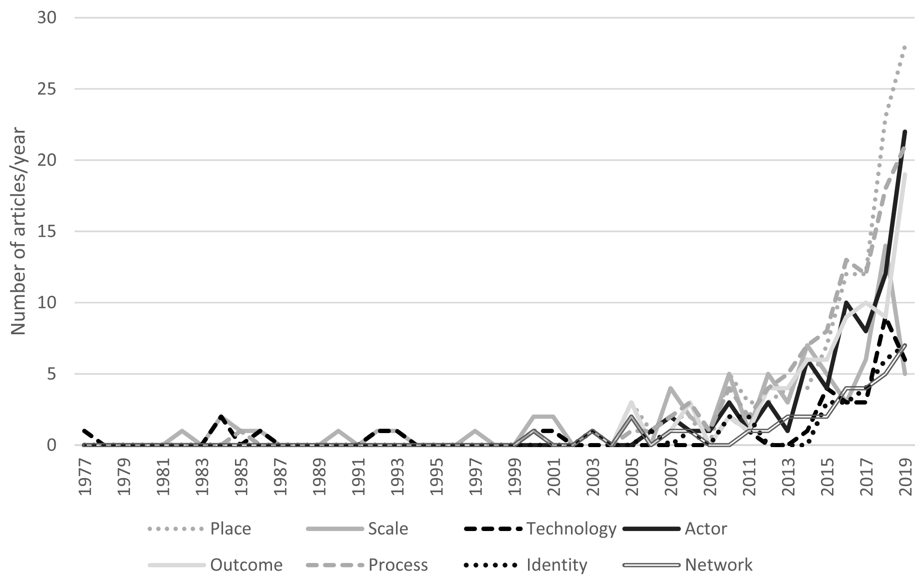

Fig. 6. Ascription of meanings over time. Source: Authors.

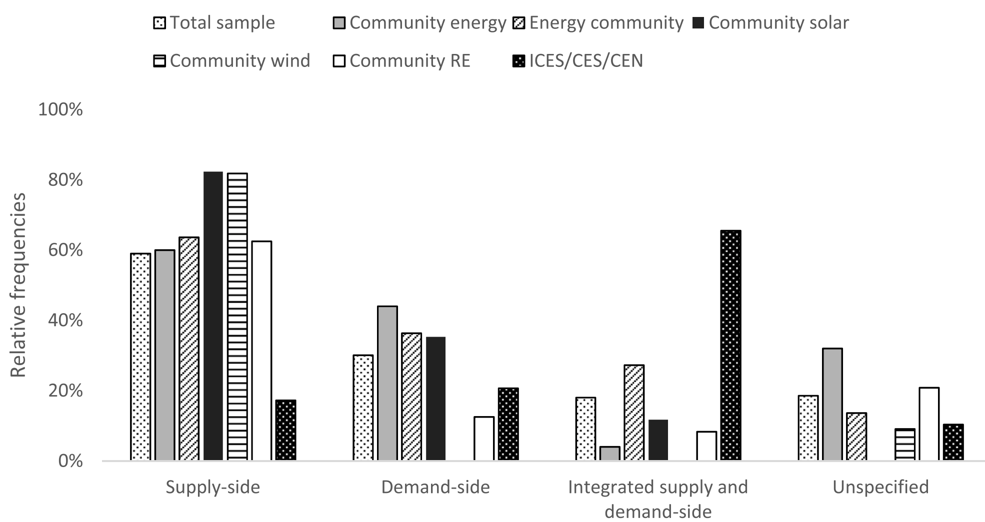

Fig. 7. Activities along the energy supply chain by concept. Source: Authors. Note: Results for "solar community," "wind community," and "renewable energy community" are not included in the figure, as they are found much less frequently in the literature than the other concepts.

For example [90, p. 1] argued that community-based energy projects "envisage a more localized, community-oriented energy system with more autonomy and a greater role for civic participation and influence." Political objectives are more frequently mentioned in relation to community energy, likely because this concept is more established in the energy social sciences compared to other concepts.

Social objectives are mentioned in 16% of definitions. They are most prevalent in the literature focusing on the concept of community energy (about 25% of the definitions), again reflecting the stronger anchorage of the energy social sciences. The set of social relations formed by communities is expected to influence how energy technologies are developed and how outcomes are distributed among members. Presumed social benefits of communities include "income generation, tackling fuel poverty, community regeneration, increased social cohesion, addressing inequalities, and skills development for local people" [79, p. 534].

Objectives relating to energy autonomy are in fifth position, occurring in about 14% of the definitions. Energy autonomy is strongly associated with ICES/CES/CEN, reflecting the relevance of these concepts for promoting energy independence (for example, community energy storage). Objectives related to energy autonomy are also particularly associated with community solar, which points to the versatility of such projects as both an attractive avenue for financial investment and a means for paving the way to a different energy system entirely.

Also mentioned in 14% of definitions, infrastructural objectives share the fourth rank with energy autonomy motives. They are particularly prevalent for the concepts of ICES/CES/CEN, highlighting the roles that these technologies and infrastructures are expected to play in enhancing energy networks. For example [52, p. 131] noted that CES "can perform several applications with a positive impact for both end users and the network." They are "located closer to end users and this enhances reliability, security of supply and flexibility."

When considering the evolution of objectives over time (see Fig. 10), it can be observed that environmental objectives have been most frequently cited in the definitions since 2012. Economic objectives have grown steadily since 2018 after a period of stagnation, becoming the second most frequently mentioned objectives in 2019, just above social objectives. As mentioned previously, this surge in the frequency of economic objectives may be related to the recently growing literature on

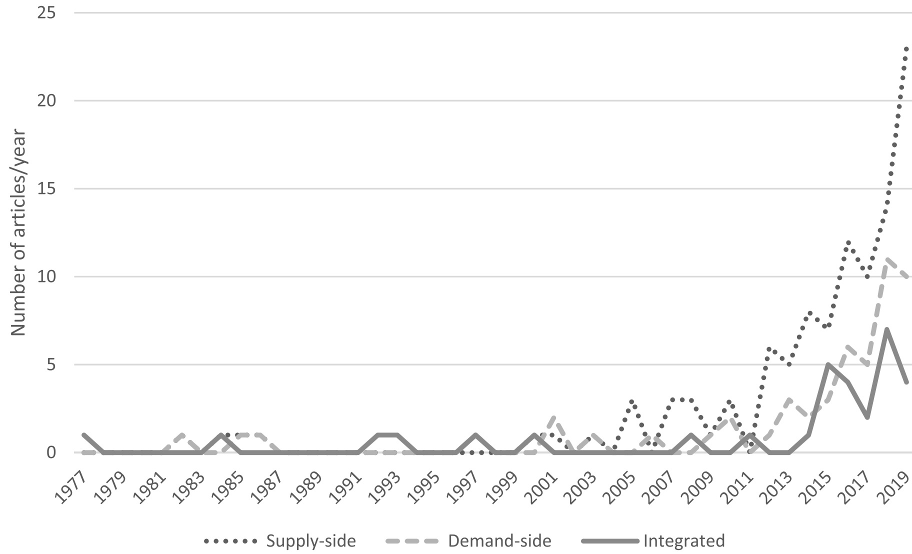

Fig. 8. Activities of communities over time. Source: Authors.

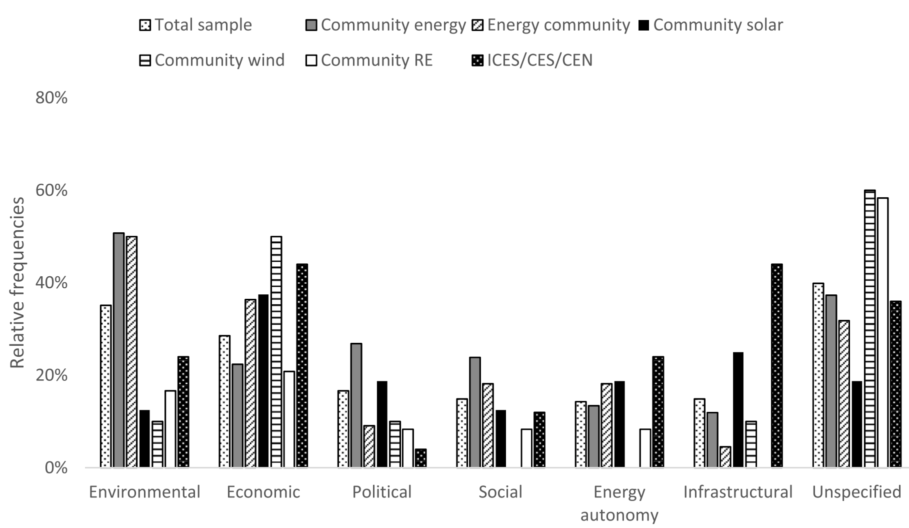

Fig. 9. Communities' objectives by concept. Source: Authors. Note: Results for "solar community," "wind community," and "renewable energy community" are not included in the figure, as they are found much less frequently in the literature than the other concepts.

community-based and peer-to-peer energy markets, for which economic objectives play a significant role. Social objectives grew steadily until 2017 but decreased in 2018. They have risen again since 2018, but energy autonomy and political objectives follow, with energy autonomy seeing an upsurge between 2017 and 2019, while mentions of political motives have increasing steadily since 2014, although less rapidly than social and economic objectives.

5. Discussion

Our results confirm that there is a multiplicity of concepts referring to community-based initiatives in energy systems, and they also show that the terms "community energy" and "energy community" have become predominant in the literature. Furthermore, they demonstrate that these concepts present striking variations, particularly with regard to the meanings ascribed to community and the alleged objectives pursued by communities. Notably, more social aspects of community (the meanings of community as a process, as an actor and as an identity, but also the political and social objectives pursued by communities) are particularly prominent for the concepts of community energy and community renewable energy, reflecting the strong anchorage of these concepts in energy social sciences. This is also reflected in our keyword analysis, which shows that "community energy" connects to keywords reflecting the "process" dimension, unlike "energy community" or other concepts.

This association of social aspects of community with the concepts of community (renewable) energy contrasts with concepts such as ICES/CES/CEN and community solar, for which a clear emphasis on community as "scale" and "technology" and on infrastructural and economic objectives can be observed, whereas the more social aspects are mentioned less frequently. While these observations may reflect the anchorage of these concepts in the engineering community, they also indicate that the energy systems covered by these concepts are primarily perceived as being of a technological and economic nature, with less importance being assigned to the social or political aspects of communities. Regarding community wind, notions of community as "place," "outcome," "process," and "scale" emerge as crucial, which, as we suggest in our analysis, stems from the importance of these aspects for the social acceptance of wind turbines.

Furthermore, the prominence of meanings and objectives varies over

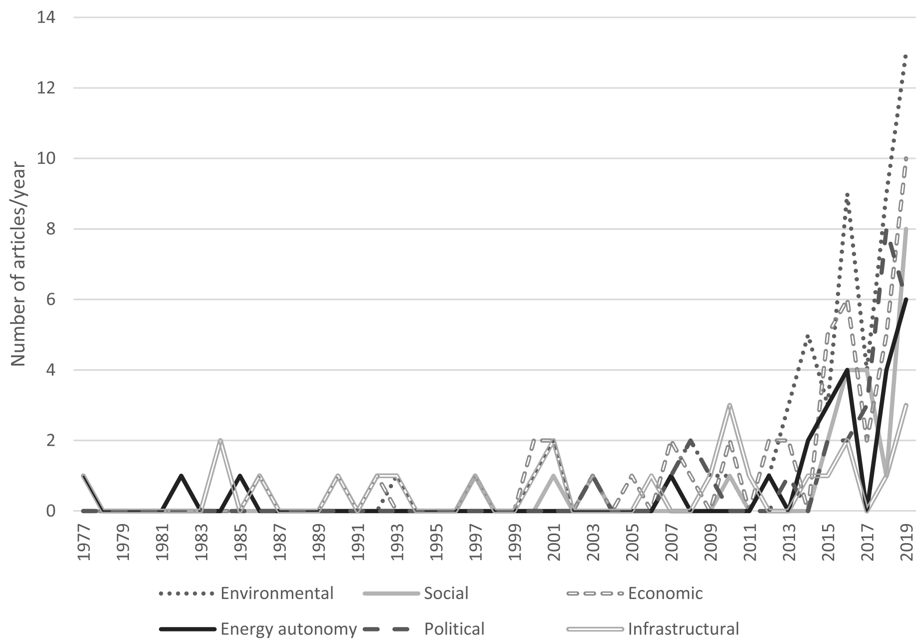

Fig. 10. Evolution of objectives over time. Source: Authors.

time. In particular, our findings show a trend toward a relatively higher importance of the meaning of community as "place," while other notions of community have also grown, but more slowly. Thus, in relative terms, there is a shift away from the meaning of community as "process," which dominated the literature between 2013 and 2017, with a particular emphasis on citizen-led, bottom-up, and collective processes of participation in energy transitions. This may indicate that these aspects are receiving less scholarly attention over time, to the benefit of other, more technical aspects. Similarly, we observe a trend toward a relatively stronger focus on economic objectives over time.

Based on these observations, a distinction, similar to the one made by Ref. [91] between the "critical" and "practical" streams of thought in the literature on social innovation, could be made between "transformative" and "instrumental" notions of community. Transformative notions emphasize the social and political motivations of communities over economic gain as well as the potentially transformative features of communities as drivers and blueprints for profoundly different energy systems. It also emphasizes the formation of a collective community interest. Instrumental notions primarily view communities as a tool [92] to achieve economic or other outcomes that are beyond the sphere of influence of a given community. In accordance with this categorization, our findings indicate that transformative notions of community are losing ground to more instrumental notions. These trends resonate with [93, p. 895], who noted that the fast-growing literature on smart local energy systems, peer-to-peer energy trading, and community-based energy markets tends to focus on the economic objectives of communities and to provide a "partial and reductive vision of 'community' composed of aggregates of self-interested economic actors, overlooking non-market motivations characteristic of participants in CE initiatives."

These findings can also be interpreted in relation to recent trends in community energy practices and policies for community energy, which correlate with the academic discourse. In the UK, for example, policy on decentralized energy shifted from a focus on community energy to smart local energy systems [93] after the replacement of the Community Energy Unit by a Local Energy Team and the elimination of support mechanisms for CE that followed a change in the governmental regime in 2015 [94]. This shift has been accompanied by a tendency toward making community-based energy projects more professional and commercial [95–97]. Prior to the UK's actions, in 2008, Denmark introduced a policy scheme for community ownership that mandated project developers to offer local residents within a 5-km radius a certain number of shares. This initiative further changed the practice of Danish community wind projects, which had already seen a decline in grassroots-initiated community programs in favor of financial participation schemes for residents [98]. In Germany, the 2016 reform of the renewable energy act formally defined citizen energy companies and cooperatives [99]. The intention of the policy was to exempt small-scale community wind projects from high risks and costs when participating in tenders and thus enable bottom-up initiated and locally controlled projects. However, the effect was that many professional developing companies designed their projects to fit the formal label of citizen energy companies [100,101].

On the European level [102, p. 10] argued that despite efforts to put citizens "at the core of the Energy Union" (European Commission, 2019), "the legal text supporting the package (Council Regulation (EU) No. 018/1999 of 12 December 2018) conflates consumer and citizen to the point where traditional ideas of citizenship and 'the citizen' become essentially void of any real meaning." In contrast [17], emphasized that the concepts of citizens and renewable energy communities in EU law recognize principles of non-commercial purpose, effective citizens' control, or democratic governance to some extent. However, they run the risk that in the process of transposing EU law into national law, many large utilities and industrial consumers will attempt to fit within these definitions to save costs or use them to commercialize a broad spectrum of services directed toward consumers (p.7). As a way forward [103], propose to recognize such renewable energy communities as legal entities to be embedded within a separate socio-legal institution of civil energy networks, alongside the state and the market. These examples show that communities in energy systems have constantly changed in meaning, which is reflected in policies and also induced by policy.

Two major trends seem to account for the shifting notions of community in energy systems. Firstly, as respective projects have become innate to energy markets in many parts of the world, academic interest in community energy is growing and spreading to formerly unconcerned fields of research (e.g., economics as well as engineering and technical studies). Secondly, state programs promoting renewable energies are discontinued as their roll-out gains momentum, which comes to the detriment of less competitive projects led by laypeople and citizen groups. Hence, after the early stages of renewable energy promotion brought about conditions in which smaller, semiprofessional and even grassroots projects could thrive [104], in light of the progress in market introduction, projects implementing instrumental rather than transformative notions of community in energy systems come to the fore. While this development narrows the space in which communities can operate, it might also pose an opportunity for a wider variety of communities to get involved, particularly if it is accompanied by the emergence of new intermediary organizations and business models that lower transaction costs and support existing and aspiring communities with various aspects of project development [97].

This evolution may also have the potential to address some of the concerns in terms of social and spatial equity related to the expansion of community-based energy systems (notably the need for a higher involvement of low-income households [105], regions [106] and countries [107] to foster renewable energy deployment around the globe) if it enables the development of new business models and organizational innovations that account for the particular characteristics of these groups (e.g., low to no access to capital resources for upfront investment). Here, first examples such as energy-as-a-service and contracting/third-party financing concepts [108,109] as well as consumer stock ownership plans (CSOP) [110] have already been introduced into the energy sector.

Acknowledging the growing emphasis on instrumental notions of community does not mean that economic motives to form and join communities in energy systems did not previously play a role. They have always been pivotal in initiating and motivating new members to join projects, as indicated by previous studies [23,41,61]. However, in most cases, these economic objectives have been pursued alongside other social and environmental objectives and have been embedded in processes of collective citizen participation. In contrast, the trends observed in the literature and in the policies of various European countries run the risk of placing the emphasis on the sole instrumental and market values of communities, thereby blurring their distinctiveness from more commercial actors and diluting the unique contributions that they could make in just energy transitions.

This emphasis on instrumental conceptualizations of community may have various adverse consequences. For example, considering community organizations purely as investors with a certain amount of capital at their disposal could prompt governments to offload their responsibility for investing in the energy transition onto community groups [111]. Furthermore, in the context of renewable energy planning, renewable energy developers offering economic benefits to nearby residents without allowing any form of genuine participation and co-determination can be perceived as financial "bribes" to gain people's acceptance for technology development [112]. Regarding new energy business models such as peer-to-peer energy trading, overlooking the socio-cultural and political embedding of the communities involved may be detrimental to their success and their adoption by people. For instance, in a field research carried out in rural India [113], found that preferred returns for energy provided to peers varied depending on the prosumer's personal relationship with their peer or community. The authors found that the closer the social connectedness of energy providers was with the consumer, the more likely they accepted returns different from in-cash payments, highlighting the grounding of energy trading in the social and cultural reality of people's life. Similarly, results from a discrete choice experiment conducted with prosumers in the Netherlands showed that a majority of prosumers would be willing to provide surplus electricity for free or for non-monetary compensations, especially to energy-poor households, showing the importance of non-monetary returns to advance a socially just energy transition [114].

By contrast, community-based energy practices associated with transformative conceptualizations have contributed towards substantive societal and political goals that go beyond the field of energy. Maintaining a role for such conceptualizations would mean acknowledging communities in energy systems as an institutional opportunity for politically motivated collective action [21], laboratories for citizen participation and spaces to prefigure alternative energy models [115, 116]. For example, there has been large attention to communities specifically connected with the organizational form of the cooperative. Cooperatives, by definition, are purpose-oriented organizational forms that serve the economic, social or cultural needs of their members.[2] In contrast to being a purely instrumental scheme for distributing financial benefits *among* communities, renewable energy cooperatives have established themselves as independent market players often emerging *for* communities. They are enabling social innovations [117], empowering communities [118] and influencing the rules of the energy field from the local city level [119] to the supra-national EU level [120], even if the size of these benefits depends on the concrete shape that these cooperatives take in specific contexts [27].

Admittedly, any prediction of the future use of community in the global academic and policy discourses remains highly hazardous. Looking at the recent experiences of Germany and Greece, two countries that have implemented policies to support "citizen energy companies" and "energy communities" respectively, there has been a surge of renewables projects developed specifically under "community" labels. In both cases, conceptual stretch has been observed by critics, such as profit-oriented companies developing business models which superficially fit the community label but actually have little to do with some of the original intentions behind such policies (e.g., to promote grassroots activity in the energy sector) [75,100,101,121]. Concluding from these examples, what is meant by "community" in energy systems varies and, thus, remains vague overall – and so does the future use of the term. There is a risk of overstated expectations or misuse as much as there is an opportunity to ground realistic ascriptions to "community" regarding its limits and capacities. Continued research on the notion of community (and how it is implemented in practice) is crucial to observe, analyze, and evaluate these trajectories.

6. Conclusion

Community and energy are intrinsically polysemous and malleable terms. While this polysemy and malleability have contributed to the momentum gained by the concepts of community energy, energy communities, and related notions in academic and policymaking circles, they have also led to definitional confusion and ambiguity. It is not the purpose of this paper to provide here a unique definition of community in energy systems, since, as argued by Ref. [18, p. 2], "what community means should remain open, and there is not any one aspect that community, or [community renewable energy], should mean." Instead, this paper has sought to bring conceptual clarity and transparency in this field of study by analyzing the prevalent meanings attached to this concept in the scholarly literature on energy systems. It has done so by reviewing a set of 405 articles through an author keyword network analysis and an in-depth and systematic examination of 183 definitions of a set of energy-related community concepts. While at least eight reviews on community energy and related terms have been published so far, this study is the first comprehensive and systematic review, to the best of the authors' knowledge, that has examined the diverse meanings ascribed to the main energy-related community concepts. It theoretically advances our understanding of community in energy systems by critically reflecting on the implications of observed variations in its conceptualization across engineering and social sciences, and on the evolution of dominant conceptualizations over time.

Findings show that despite the multiplicity of concepts, community energy and energy community dominate the literature. Moreover, there are important variations in the relative usage of meanings attached to the notion of community in energy systems and in the alleged objectives pursued by communities across different concepts and over time. In particular, there is a shift away from community as a process and an

[2] We are referring to the International Cooperative Alliance's definition of cooperatives, based on a set of values and principles (www.ica.coop).

increasing emphasis on community as a place. Economic objectives pursued by communities are also becoming increasingly prominent in the literature. These trends, which may stem from the recent emergence of literature on peer-to-peer energy trading and community-based energy markets rooted in the economics and engineering literature, arguably reflect a relative reduction in scholars' attention to transformative notions of community that emphasize collective and grassroots processes of participation in energy transitions, to the benefit of instrumental conceptualizations of community focusing on more technical and economic aspects. This growing focus on instrumental notions of community runs the risk of placing the emphasis solely on the instrumental and market values of communities, thereby blurring their distinctiveness from more commercial actors and diluting the unique contributions that they could make in advancing just energy transitions.

These trends also correlate with changes in decentralized energy policies in various European countries, where a shift away from grassroots-initiated community initiatives toward more professional and commercial actors and programs can be observed. This evolution will likely have a profound impact on the nature of community participation in energy systems, but the ability of a broader diversity of communities to participate could be preserved, provided that intermediaries and network organizations succeed in improving the economics of community generated electricity further and that accessible models of community involvement are able to guarantee the participation of financially less well-off end-users.

This study is not without limitations, and fruitful avenues for further research remain. First, the geographical scope of studies is likely to differ across concepts. For example, some authors note that the term "community energy" tends to be Anglocentric, holding less traction in the rest of the world [21]. Future research could further explore geographical patterns in the use of the different concepts. Second, future studies could analyze in greater depth how the local bio-physical context, the local actors' characteristics and the local institutions shape respective notions of community [see also 33,113,122]. For example, communities of place often consists of people who are primarily motivated by socio-economic matters, such as gaining access to energy supply and advance living standards in rural or remote settings. Conversely, more profit-oriented communities are more likely to form in the absence of such necessities [104]. Third, our analysis is focused on community, but other terms have been used to examine similar concepts, such as "energy citizenship" [123] and "civic energy" [124]. Thus, future studies could expand the analysis to include different terms. Fourth, our study is restricted to the English language. Subsequent studies could examine how these concepts and other terms are used in different languages, such as French or German, and which roles language and culture play in conceptual proliferation (and whether and how this is related to substantive differences in the shape that communities takes in these contexts). Fifth, collaborations between authors and the influence of publications and journals in the field are promising topics for further research—through analyses of co-author networks and citation statistics, for example. It is hoped that this paper will encourage future research that brings additional elements to the discussion and further illuminates the conceptual underpinning of community in energy systems.

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.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.rser.2021.111999.

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