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Understanding the dynamics and conceptualization of environmental citizenship and energy citizenship: Evidence from the existing literature

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This study seeks to better understand the relationships between environmental citizenship, energy citizenship, and related phenomena and the theoretical development and operationalization processes of environmental citizenship and energy citizenship in the path towards the energy transition and climate change mitigation through a bibliometric analysis. Doing so first provides an overview of how these concepts are defined in the literature establishes the frameworks for environmental citizenship and energy citizenship, including the characteristics, drivers, and pathways to their operationalization. The subsequent bibliometric analysis is conducted *via* the VOSviewer software, with more than 1,300 titles from the Web of Science database published between 1992 and 2021. The search keywords are "environmental citizenship" and "energy citizenship". The results from the analysis highlight the terms sustainability and behaviour as the overarching concepts and common points of discussion regarding environmental citizenship and energy citizenship. Moreover, although environmental citizenship preserves its central position in the scholarly debate, there is a shift towards the phenomenon of energy citizenship and a set of emerging themes including "justice", "energy democracy", and "sustainable development".

KEYWORDS

environmental citizenship, energy citizenship, energy transition, bibliometric analysis, VOSviewer

1 Introduction

One of the main pillars of climate change mitigation is the energy transition, which focuses on transforming the energy system from its current fossil-based construct to a low- (or zero-) carbon structure (IRENA, 2022). Energy transition focuses on the utilization of smart energy systems, including the renewables deployment, a restructuring of the energy markets, and implementation of a supporting policy

framework that aligns with and facilitates the required implementations towards reducing carbon emissions, hence supporting climate change mitigation (IRENA, 2022). The energy transition objectives can be achieved only by including individuals in the energy system as active and key stakeholders. In this respect, the energy transition implies the increasing role of citizens in the energy system. With the energy transition, citizens move from their traditional roles as consumers to producing, storing, selling energy. That is, the individuals become prosumers rather than consumers. On the other hand, this active participation of individuals in the low-carbon transition, with a redefinition and upscaling of their roles, requires their empowerment of individuals in the energy system.

The reflections of such change in the legislative, administrative, social, community, and individual spheres become critical. On the formal side, pertaining to the focal areas of the energy transition, changes in the energy market structures need to be established, the legislative and administrative structures need to be updated to remove the restrictions and barriers that pose challenges to the involvement of individuals in the energy market. Likewise, considering the policymaking aspect, policies enhancing the more active involvement of individuals or communities in the energy system, such as incentives or tax reductions regarding community energy initiatives or energy cooperatives, need to be formulated and implemented. Given the legislative and administrative framework, the individuals need to identify and traverse their pathways within the energy system on the social, community, and individual sides. This participation may range from adopting a mind-set to change habits, adopting climate-friendly lifestyles, or developing pro-environmental behaviour.

Connecting to the concept of energy transition, energy citizenship highlights individuals realising the shift from their traditional roles as consumers or "the public", towards becoming significant stakeholders in the energy system (Devine-Wright, 2007). Within the energy system, citizens are expected to take innovative paths to shape and redefine the system through their actions and participation in policy making. At this point, emerging technologies support the citizens and act as drivers of energy citizenship (Schot et al., 2016). In this respect, three focal technological areas are e-mobility, smart energy systems, and household energy technologies. Along with technology, principal drivers of energy citizenship are awareness in terms of environmental issues and climate change, energy and environmental equity, and energy justice (Devine-Wright, 2007).

Environmental citizenship and energy citizenship share common grounds because the energy transition is the main driver for both phenomena. Regarding environmental citizenship, the low-carbon or zero-carbon principles of the energy transition align well with the pro-environmental principles of environmental citizenship. Moreover, the oft-cited activism characteristic of environmental citizenship is in par with the foremost principle of the energy transition that requires the empowerment of citizens in the energy system. These notions also match very well with the energy transition, and in particular, energy citizenship that emphasizes the active involvement of individuals within the energy system. Such involvement can be achieved through prosumerism, participation in energy communities, establishing energy cooperatives, and paves the way for a decentralised and more democratic energy system (Wahlund and Palm, 2022).

Moreover, environmental citizenship and energy citizenship also align in terms of their position concerning the traditional conceptualization of citizenship. The conventional citizenship perspective refers to states countries with physical boundaries, hence territorial. The citizens are connected to these based on the administrative and legislative constructs, including the reciprocal rights and responsibilities. However, environmental citizenship and energy citizenship are not territorial, and there is no authority that grants or denies the right to be an environmental citizen or energy citizen rather, these types of citizenship are based on (individual and collective) awareness, an understanding of (environmental, ecological, or energy) justice and equity, responsibility, empowerment, participation (in, for instance, environment and energy-related decision-making and environment and energy-related policy making), (attitude, behaviour, and lifestyle) change, and activism.

Although environmental citizenship and energy citizenship are closely related, the emergence and temporal development of the two concepts differ. Environmental citizenship has a more global focus, hence pertains to a more global set of environmental and global targets associated with climate change and the protection of the ecosystem. Energy citizenship is more individual-oriented focuses more on change of habits, behaviours, and lifestyles, with rather local achievements towards global targets. Therefore, a line of researchers perceives energy citizenship as a component of ecological or environmental citizenship. The viewpoint adopted by this perspective is that energy citizenship refers to the awareness and pro-environmental energy choices and behaviours of individuals based on their responsibilities for the environment (Islar and Busch, 2016; Kenis, 2016). Hence, the energy transition through, for instance, the use of renewable sources and individuals' participation contributes to environmental citizenship.

This manuscript utilizes bibliometric analysis in order to provide an analysis of how the concepts of environmental citizenship and energy citizenship have emerged, developed, and investigated in the literature, as significant phenomena in the climate change and energy transition debates. This study also presents a trajectory of both terms based on their occurrences in the academic studies and other emerging themes. To the best of the authors' knowledge, this is the first study to assess the evolution of the concepts of environmental citizenship and energy citizenship in the literature. Conceptually, the strong relationship between environmental citizenship and energy

citizenship with phenomena such as climate change, energy transition, ecological and environmental justice, ecological and environmental equity, protection of the ecosystem, and energy justice are well-established. This manuscript also contributes to the literature by being the first study to elaborate on how and to what extent the studies in the literature reflect such relationships by identifying clusters of closely-related terms, along with the strengths of links within a particular cluster and between the clusters of terms. The subsequent analysis results are significant in understanding whether the relationships between the related phenomena are established as foreseen, contributing to the theoretical development and operationalization processes of environmental citizenship and energy citizenship, in the path towards the energy transition and climate change mitigation.

2 Literature review

Two closely-related phenomena, environmental citizenship, and energy citizenship, have been debated in the literature as significant drivers of climate change mitigation and the energy transition. As a concept that emerged much earlier than energy citizenship, environmental citizenship refers to the more general participation and contribution of individuals towards sustainability. The concept of environmental citizenship aims at improving the skills for behavioural change, and involves a process of building pro-environmental attitude, increasing awareness and information provision concerning sustainability and sustainable lifestyles (Hawthorne and Alabaster, 1999). On the policy and administrative counterpart, such a process needs to be supported by moving from a government approach to a governance approach (Meerah et al., 2010).

European Network for Environmental Citizenship (ENEC) emphasizes the notions of responsibility and pro-environmental behaviour as key components of environmental citizenship (ENEC, 2018). The pathways of individuals towards environmental citizenship are exemplified by generic participation in the mitigation of existing environmental problems and the prevention of environmental problems to emerge. The ultimate goal of environmental citizenship is achieving sustainability through a healthy relationship with nature. Likewise, the scope of activities for environmental citizenship covers the individuals' actions and in collaboration with society and with their communities. The expected impact is a change in the public and private arenas, and the scope of change might be local, regional, or even global (ENEC, 2018).

With this perspective, the conceptualization of environmental citizenship is based on a very broad framework in terms of the activities, types of actions in terms of stakeholders, and the level of impact. This is particularly since environmental problems and their impacts vary on a scale from local to global, hence the response needs to be on par with these (Valencia Sáiz, 2005). Accordingly, environmental citizenship implies global-level, collective citizenship by requiring global-level awareness, where individuals act for the environment, hence non-territorial citizenship, instead of the classical definition of citizenship that connects with borders, nations, or states (Jelin, 2000; Horton, 2006).

The operationalization of environmental citizenship is reflected by following the principles of protecting nature (e.g., by decreasing carbon footprint, reducing waste) and preserving biodiversity (e.g., by protecting flora and fauna, abandoning the use of pollutant chemicals, practicing regenerative agriculture), adopting habits and behaviour such as recycling, energy savings, preferring products with low carbon footprints, conserving energy and other resources (Ellis and Waterton, 2004), supporting and participating in the formulation and implementation of pro-environmental policies (Bell, 2005).

As environmental citizenship inherently depends on individuals' caring for the environment -even though they may not have encountered visible effects directly-, internalization of the concept is merely based on the perception of justice. To this end, conceptualizations of environmental citizenship in the literature position the phenomenon relies on ecological/environmental justice (Hayward, 2012). On the other hand, the global and environmental emphasis associated with environmental citizenship calls for activism in order that the concerns can be sufficiently addressed in the presence of the already populated daily agenda of individuals, the community, and the governments. Hence, environmental citizenship has been characterized mainly by ecological justice and activism (Isin and Nyers, 2014; Cheah and Huang, 2019). The framework for environmental citizenship is provided in Figure 1.

The debate on energy citizenship is more recent than environmental citizenship. Energy citizenship emphasizes the changing roles of individuals in the energy system.

The conceptualization of energy citizenship that refers to the active participation of individuals within the energy system through, for instance, energy communities, prosumerism, or activism, leading to a more decentralised and more democratic energy system (Wahlund and Palm, 2022). In addition to the individual-oriented perspective, collective actions such as community energy initiatives, especially focused on renewable energy systems have proven to be widely efficient means of operationalizing energy citizenship and progress towards achieving the energy transition. Such initiatives allow the empowerment of individuals, making them energy producers, owners and decision-makers in the energy system, players in the energy market, and stakeholders for the formulation of energy-related policies (Koij et al., 2018; Ryghaug et al., 2018). Hence, the community and social aspects of energy citizenship also relate to their more active roles in terms of the political arena. Becoming a stakeholder in terms of energy policy making is not limited to the scope of energy communities. Energy citizenship also foresees individuals to actively participate

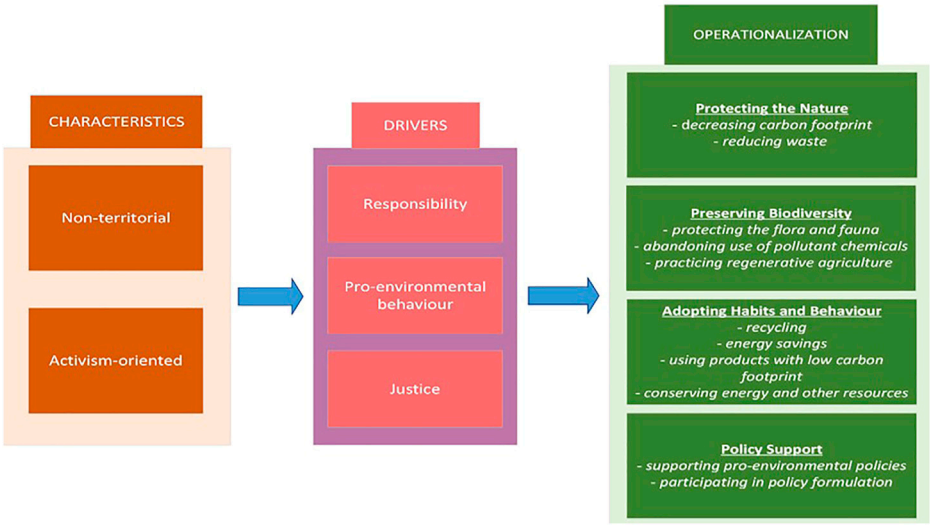

FIGURE 1
Environmental citizenship framework.

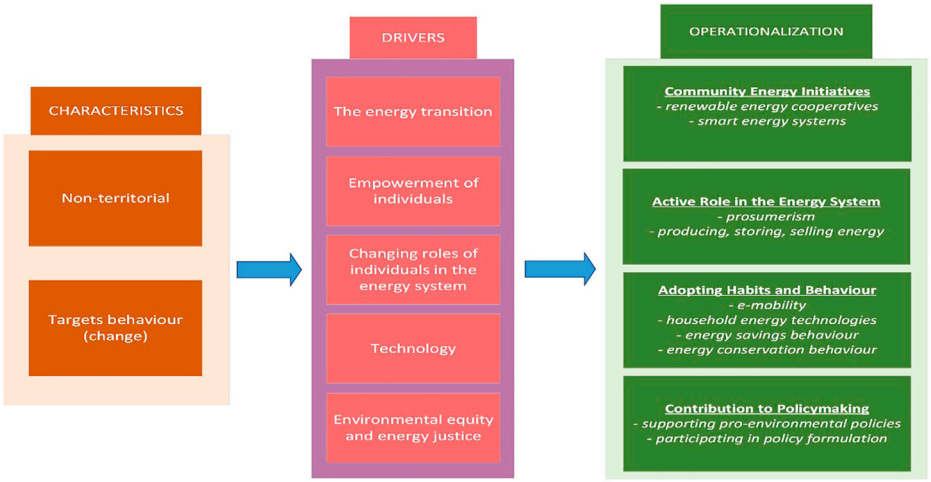

FIGURE 2
Energy citizenship framework.

in terms of criticizing, stating their ideas, being involved in activist groups or demonstrations concerning energy policies or energy-related issues (Rydin and Natarajan, 2016; Hasanov and Zuidema, 2018; Ryghaug et al., 2018). The framework for energy citizenship is provided in Figure 2.

By the early 1990's, the concept of environmental citizenship was cited in only 18 publications (e.g., Frankenfeld, 1992; Powell, 1996; Espejo and Stewart, 1998; Hawthorne and Alabaster, 1999). For example, Frankenfeld (1992) deals with the concept of citizenship from a technological perspective, introducing the concept of "technological citizenship" to the literature to protect people from environmental hazards that lead to environmental vulnerabilities for the future (Frankenfeld, 1992). Hence, the study had a more technical focus on the concept of citizenship. Towards the 2000's, the studies in the literature started to focus on the efforts of the society to accomplish global environmental sustainability since rapidly increasing human activities, and particularly industrial

activities, require effective measures against the creation of waste and carbon dioxide emissions from fossil fuels for ecosystem protection. Furthermore, Espejo and Stewart (1998) correlate individual self-interest and community actions for long-term global environmental sustainability through an emphasis on the linkage between corporations and society (Espejo and Stewart, 1998). While such emphasis results in a need to take measures against environmental degradation within the framework of citizenship principles, it also necessitates defining the components of environmental citizenship. To this end, Hawthorne and Alabaster (1999) identify these components that can also be conceptualized as the ways to achieve environmental sustainability and environmental citizenship, including "information, awareness, concern, attitudes/beliefs, education and training, knowledge, skills, literacy and responsible behaviour". The authors also highlight these components as the "working model of environmental citizenship" (Hawthorne and Alabaster, 1999).

On the contrary to the limited number of studies in the 1990s, the concept of environmental citizenship gained notable popularity by the 2000's. This is evidenced by the upward linear trend in the number of related articles over the years. An overview of the most cited publications in the 2000's concerning environmental citizenship reveals that the focal areas of these studies vary from behaviour, citizenship science, to environmental science, energy, organizational citizenship behaviour, climate change, and sustainability (Seyfang, 2006; Dobson, 2007; Chabowski et al., 2010; Dono et al., 2010; Boiral and Paillé, 2011; Paillé et al., 2013; Gabrys, 2014; Raineri and Paillé, 2015). The literature search results also demonstrate that the studies pertaining to environmental citizenship started to become more interdisciplinary, interpretive, and socially-constructed as of the 2000s. For instance, Gabrys (2014) discusses how digital technologies contribute to achieve sustainable urbanism, addressing urban environmental citizenship in the smart cities (Gabrys, 2014). In this sense, urban environmental citizens are regarded as responsible entities that make "informed, responsible choices" (Mitchell and Casalegno, 2008). Similarly, Dono et al. (2010) examine the relationship between "environmental activism, pro-environmental behaviour and social identity", resulting in the citizenship aspect of environmental behaviour shaping environmental activism (Dono et al., 2010). This shows how environmental citizenship has gained a socially-constructed meaning in the literature. On the other hand, Raineri and Paillé (2015) investigate how the social–psychological dynamics in organizations influence environmental citizenship behaviours (Raineri and Paillé, 2015). However, their approach is based on organizational citizenship behaviour and environmental commitment, demonstrating that the concept of environmental citizenship started to become more interdisciplinary since it was addressed by varying disciplines and study domains.

Likewise, the studies related to energy citizenship started to be published in the literature by the beginning of the 1990's. These studies were conducted with different primary focal topics such as citizenship, behaviour, organizational citizenship, and energy, where energy citizenship was framed as a secondary or sub-topic (Pasmore and Fagans, 1992; Bewig, 1994; Rosko, 1994; Patterson, 1999; Heyman, 2000). At the beginning of the 1990's, the majority of the studies in the energy citizenship literature mainly focused on organizational aspects. However, the concept of participation gained prominence in the 2000's. For example, Patterson (1999) examines the nature of citizenship *via* an emphasis on the aspects through which individuals perceive their rights and obligations in a community (Patterson, 1999). In this sense, participation reveals the individuals' perception of their rights and responsibilities in society. This aspect of participation is diligently associated with citizenship since it affects public-level decision-making and resource allocation.

The boost in the number of studies concerning energy citizenship is only observed after 2010, where energy citizenship was also perceived as the main topic of the studies (Rojas et al., 2011; Alon and Cherp, 2012; DeWaters and Powers, 2013; Kuch and Titus, 2014; Slee, 2015; Rasch and Köhne, 2016; Warbroek and Hoppe, 2017; Ryghaug et al., 2018; Lennon et al., 2019; Wuebben et al., 2020; Moles-Grueso and Stojilovska, 2022). After 2010, the energy transition started to become a key concept in the energy citizenship literature. Most of these papers conduct case studies to examine the concept of citizenship in the context of the energy transition. For instance, Rasch and Köhne (2016) conceptualize citizenship as a compromise between the citizens and governments in decision-making during the energy transition through a case study on hydraulic fracturing in the Netherlands (Rasch and Köhne, 2016). Similarly, Warbroek and Hoppe (2017) test the impact of local low carbon energy initiatives on policy and governance in Dutch regions, with an outlook on dynamic energy citizenship that shapes policy innovation (Warbroek and Hoppe, 2017). Since the energy citizenship literature studies address energy transition and environmental issues, it is not surprising to see increasing linkages with environmental citizenship. Therefore, as with the concept of environmental citizenship, a line can be fitted to demonstrate the increase in the number of publications regarding energy citizenship.

Figure 3 depicts the number of studies concerning environmental citizenship and energy citizenship from 1992 to 2021. Still, the number of studies pertaining to environmental citizenship is higher than the studies focusing on energy citizenship.

3 Methodology

The methodology of the manuscript follows the steps of a bibliometric analysis. As the first step, the search terms are

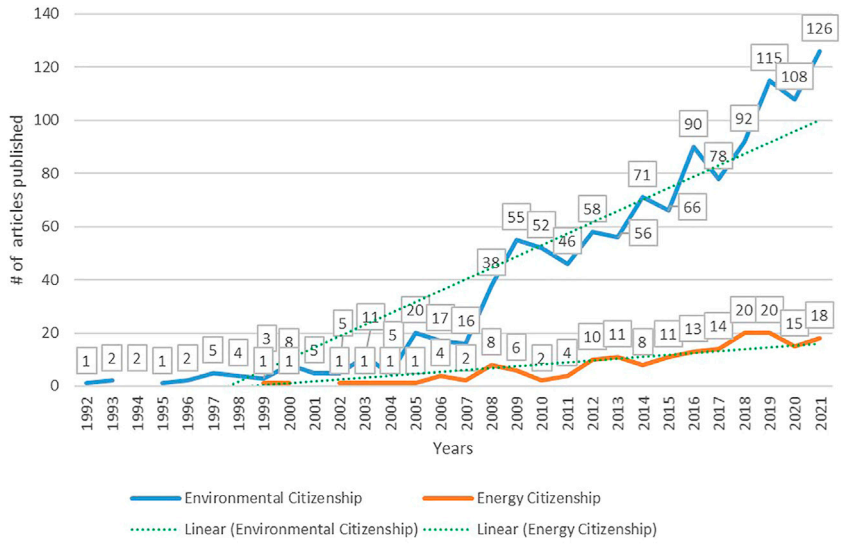

FIGURE 3
Number of publications with keywords "environmental citizenship" and "energy citizenship" (WOS database, 1992–2021).

identified. The search keywords are selected in conformance with the scope and objectives of the research. Thereafter, the repositories for analysis and the timeline are selected. The next steps are the selection of the software for analysing the search results, and performing the analysis using the selected bibliometric analysis software (Zaharia et al., 2016; Mejia et al., 2021).

Based on the scope and objectives of the research and the results of the literature review, the search terms for the bibliometric analysis were selected as "environmental citizenship" and "energy citizenship".

The search repository was selected as the Web of Science (WOS) database, since the WOS database is trustworthy, and covers reputable and high-impact titles a wide spectrum of disciplines. Moreover, the WOS database provides reference and citation tracing, which enhance the identification of research trends for a particular field (Zyoud and Fuchs-Hanusch, 2017; Echchakoui, 2020; Huang et al., 2022).

The timeframe for the analysis was selected as 1992–2021 in order to be able to assess the contemporary trends in the related research fields and trace the evolution of the research topics over two decades. The existence of only 18 publications in the early 1990s supports the appropriateness of this choice of the timeline.

The Web of Science database was queried, with the keywords "environmental citizenship" and "energy citizenship" to be searched in the Abstracts of the publications. The search for the term "environmental citizenship" in the Web of Science database within the timeframe 1992–2021 returned 1,157 manuscripts, whereas the search for the term "energy citizenship" within the same database and in the same timeframe resulted in 175 manuscripts.

Using these results, the bibliometric analysis was conducted *via* the VOSviewer software (version 1.6.17), due to its capabilities in terms of analysing documents, identifying and demonstrating the terms with highest frequencies, and the how the terms are associated. In doing so, the VOSviewer software conducts text mining and provides detailed network visualisations of the results (Van Eck and Waltman, 2010; Wang et al., 2020; Hu et al., 2022; Wan et al., 2022; Wang et al., 2022).

The bibliometric analysis in this study utilizes semantic clustering of the text data (Liu et al., 2015). Bibliometric analysis is a method based on statistical data used to measure the impacts of parameters such as scientific publications, authors, institutions, scientists, and keywords (Biresselioglu et al., 2020). An analysis of publications related to a given research discipline is known as bibliometric analysis, and it is commonly used to assess knowledge structure and development in Natural Sciences, Social Sciences, and Humanities (Pauna et al., 2019; Xie et al., 2020; Katoch, 2021; Murdayanti and Khan, 2021; Mörschbächer and Granada, 2022).

The visualizations of the VOSviewer software, including different types of maps and the identification of clusters of closely-related terms, enhance the analysis. In addition, the VOSviewer software provides the frequencies of occurrence for the most-cited terms and parameters, as well as the interactions and interrelations between these terms (Pauna et al., 2019; Wei et al., 2020).

TABLE 1 Results of the bibliometric analysis *via* VOSviewer.

Term labels	# of items	# of clusters	# Of links	Total link strengths
Environmental citizenship OR energy citizenship	103	7	1,626	9,192
Environmental citizenship	83	7	1,201	6,793
Energy citizenship	31	3	292	3,706

The quantitative analysis examines the outputs of the VOSviewer software by considering the link weights, total link strengths, and occurrence frequencies of the terms. These quantities are grouped into three main categories (High, Medium, and Low) to facilitate the analysis. The frequencies that fall into these categories are determined by dividing the range of frequencies into three equal-length intervals. The terms that have frequencies falling into the lowest one-third of the frequency range are identified as low-frequency terms. On the other hand, the terms with frequencies falling into the highest one-third of the frequency range are identified as high-frequency terms. The remaining terms (corresponding to the middle one-third of the frequency range) are categorized as medium-frequency items (Acedo et al., 2006). The second step of quantitative analysis *via* the VOSviewer software is normalization. Normalization refers to bringing data on different scales to a common scale to enhance the joint visualization and evaluation of the data. Since the bibliometric analysis provides data on links weights, total link strengths, and occurrences, normalization is applied to all three categories of data such that every item has links weights, total link strengths, and occurrences between 0 and 100 (Jin et al., 2016). Earlier studies in the literature implement various techniques for normalization. For this study, the linear (min-max) method is utilized. That is, for every category, the minimum and maximum values within the category are determined. Then, every value is normalized by converting the value to its percentile position between the minimum and maximum values. For enhancing the representation, the percentile values are multiplied by 100. The final step using the VOSviewer software is comparative analysis (Armin Razmjoo et al., 2019). At this step, the terms and clusters identified through the VOSviewer software are compared to identify common points, interrelations connections, and differences. The comparative analysis method is critical in the interpretation of the data developed as a result of the analysis and output of the VOSviewer software.

4 Analysis

With the bibliometric analysis terminology in VOSviewer, each identified term is called an “item”, or “label”. Each item is associated with " (number of) links”, “total link strengths”, and “occurrences”. These quantities are referred to as the weights for each term in the bibliometric analysis. “Links” provides a measure of how many items a particular item is connected to. “Total link strengths”, is a composite measure that shows how closely an item is connected to other items, i.e., the total strength of the links of an item with other items. Occurrences of an item denotes the frequency of occurrence of a particular item in the overall text corpus. Items that are closely related to each other form “clusters".

TABLE 2 Items with Link Weights in the High category.

Term labels	Weight <links>
Sustainability	82
Behaviour	75
Energy citizenship	75
Environmental citizenship	73
Sustainable development	72
Technology	69
Consumer	63
Consumption	62
Environmental sustainability	62
Environmental issue	61
Justice	61
Climate change	59

Summary of the results for the initial analysis of the Vosviewer software is shown in Table 1.

4.1 Frequency analysis

Frequency analysis allows for the categorization of the items (terms) based on their weights in terms of link weights, total link strengths, and occurrence frequencies. Three categories (High, Medium, Low) are defined for each weight type.

In order to define the categories, for each weight type, the range of item weights is divided into three equal-length parts. The length of each part is identified by favg by the formula:

$$f_{avg} = \left(Maximum\,Weight - Minimum\,Weight\right)\big/3 \quad (1)$$

Thereafter, the items in the “Low” category are those with the weights falling in the lowest one-third range, which is:

$$\left(Minimum\,weight,\ Minimum\,weight + f_{avg}\right) \quad (2)$$

TABLE 3 Items with Total Link Strengths in the High and Medium categories.

Term labels	Weight <Total link strength>
Justice	1,262
Demand	1,077
Sustainability	1,001
Behaviour	999
Environmental citizenship	593
Sustainable development	546
Consumer	478
Organizational citizenship Behaviour	469
Technology	457
Environmental education	450

TABLE 4 Items with Occurrences in the High and Medium categories.

Term labels	Weight <occurrences>
Environmental citizenship	380
Energy citizenship	295
Sustainability	253
Environmental education	192
Sustainable development	180
Behaviour	175
Technology	133
Climate change	113

The items in the "High" category are those with the weights falling in the highest one-third range, which is:

$$\left(Maximum\ weight - f_{avg},\ Maximum\ weight\right) \quad (3)$$

The remaining items (the weights of which fall into the middle one-third range) are identified as "Medium" category items. That is, the items with the weights falling into:

$$\left(Minimum\ weight + f_{avg},\ Maximum\ weight - f_{avg}\right) \quad (4)$$

The categories for the 103 items identified by the VOSviewer software are determined for the three weight categories (link weights, total link strength, and occurrence). These categories are depicted in Table 2, Table 3, Table 4 below. The table for the link weights (Table 2) involves the "High" category items, whereas the tables for total link strength (Table 3) and occurrence (Table 4) involves the "High" and "medium" category items, due to a small number of "High" category items for these weight types.

As illustrated in Table 2, the term "sustainability" has the highest score for link weights. The top four terms according to link weights are "sustainability", "behaviour", "energy citizenship", and environmental citizenship".

In terms of total link strengths, the terms "justice" and "demand" are the top two terms. As with the link weights, the terms "sustainability", "behaviour", and "environmental citizenship" have high total link strengths.

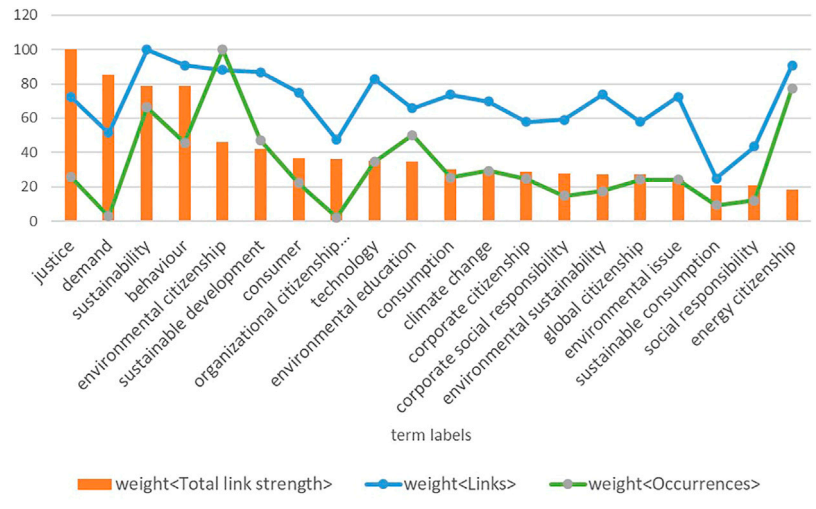

FIGURE 4
Normalized weights for the top 20 items according to total link strengths.

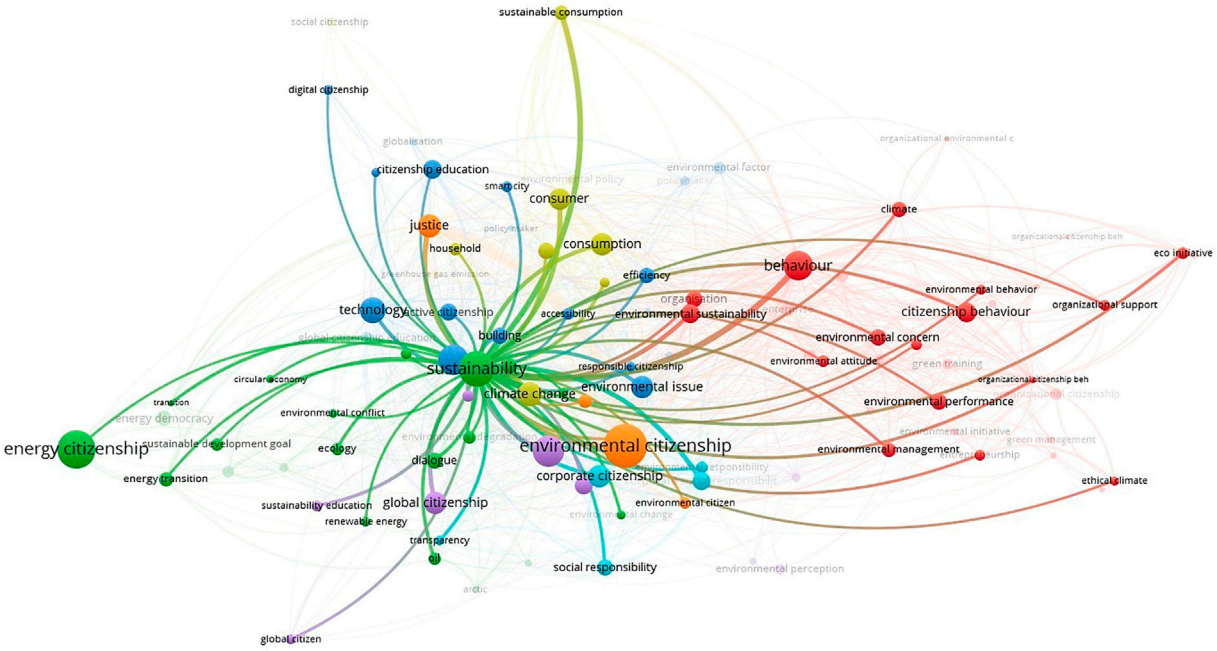

FIGURE 5
Co-occurrence analysis for the term "sustainability".

When the items are analysed based on their occurrences, the terms "environmental citizenship" and "energy citizenship" have the highest frequencies. This result is more or less expected since these terms are also the underlying search terms. The terms "sustainability", "environmental education", "sustainable development", and "behaviour" are also among the highly-cited terms.

4.2 Normalization

The normalization method is utilized to bring the data concerning three different weight types into a single common scale. In this way, the data is easier to comprehend and analyse. The normalization process is merely a rescaling of the data, hence, it does not change the relative rankings of weights of items. The formula for obtaining the normalized weights for each of the weight types (links weights, total link strengths, and occurrences) is given below:

$$Normalized\,Weight = \frac{Original\,Weight - Minimum\,Weight}{Maximum\,Weight - Minimum\,Weight}\,x\,100 \quad (5)$$

The resulting normalized weights are in a range of 0–100. Figure 4 demonstrates the normalized weights of the top 20 items with respect to total link strengths.

The figure demonstrates an agreement in terms of link weights and occurrences, with the exception of the term "environmental citizenship". This term has a higher occurrence frequency than what would be suggested by link weights. This result can be interpreted as the term "environmental citizenship" being discussed in the literature as a common, unifying term (hence, the high number of occurrences). However, in comparison, not as closely associated with the other terms. The figure also suggests that the trends in the total link strengths disagree with those of link weights and occurrences. The terms "demand", "organizational citizenship", "environmental education", and "sustainable consumption", for instance, would be expected to have lower total link strengths if they followed the trends of link weights and occurrences. These terms can be identified as those that are discussed as focal topics in the publications they are cited, resulting in a higher number of co-occurrences with other terms, hence higher total link strengths.

4.3 Comparative analysis

Comparative analysis can be utilized as a part of both quantitative and qualitative methodologies (Pan et al., 2018; Peters et al., 2020). The analysis in this section mainly utilizes the visualizations provided by the VOSviewer software, in addition to the preceding analysis.

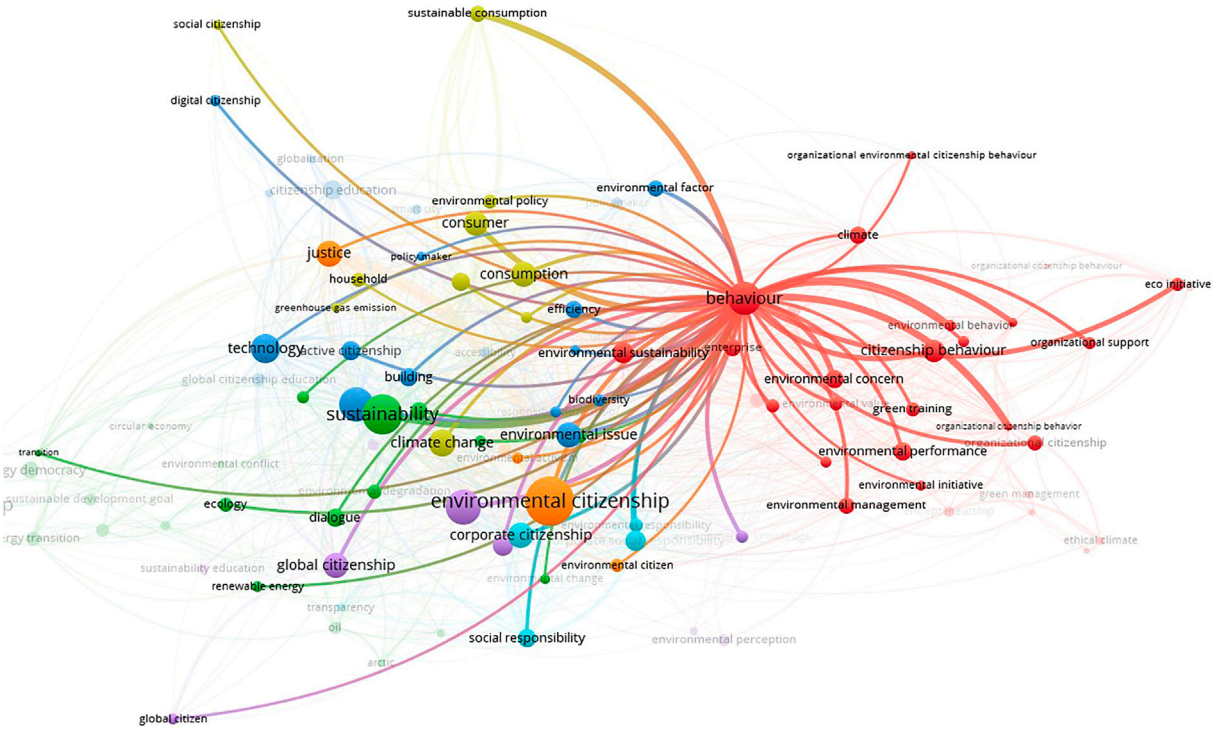

FIGURE 6
Co-occurrence analysis for the term "behaviour".

4.3.1 Co-occurrence analysis

As depicted in Table 2, the terms in the literature with the highest number of links concerning environmental citizenship and energy citizenship are sustainability, behaviour, energy citizenship, and environmental citizenship. The co-occurrence analysis presents a visualization of the sub-network corresponding to a particular term or a set of terms. Isolating the part of the network associated with a single term, the co-occurrence analysis provides an overview of what terms have been discussed together (i.e., co-occur in the literature) with the term of interest and how connected the term is with the other terms concerning environmental citizenship and energy citizenship.

The term that has the highest number of links is sustainability. The co-occurrence analysis for the term sustainability is provided in Figure 5 below. Not surprisingly, the overarching term of sustainability has direct connections with a considerably high number of terms, including energy citizenship, environmental citizenship, climate change, behaviour, consumption, technology, and global citizenship, most of which are depicted in different colours in the visualization. The existence of different colours in the co-occurrence visualization suggests that the concept of sustainability is utilized as a common base for motivating the discussions and analysis of different sets of interrelated phenomena, hence different themes regarding environmental citizenship and energy citizenship. This also emphasizes the interrelationship between the most-cited terms of sustainability, behaviour, environmental citizenship, and energy citizenship.

The co-occurrence analysis for the second highest-link term, behaviour, is presented in Figure 6. Although not as central as the term sustainability, the term "behaviour" is also linked to a considerable number of terms, including environmental citizenship, sustainability, consumer, and corporate citizenship.

The co-occurrence analysis for the term "environmental citizenship" points to a central positioning for this term (see Figure 7). As one might expect, the visualization shows that environmental citizenship is connected to high-frequency terms of sustainability, behaviour, consumer, consumption, technology, and global citizenship. A more interesting observation concerns the shift towards emerging terms that are debated around the concept of environmental citizenship, including energy transition, environmental conflict, citizenship education, sustainable consumption, corporate environmental citizenship, and environmental behaviour.

The co-occurrence analysis for the term energy citizenship is considerably more condensed as compared to those of

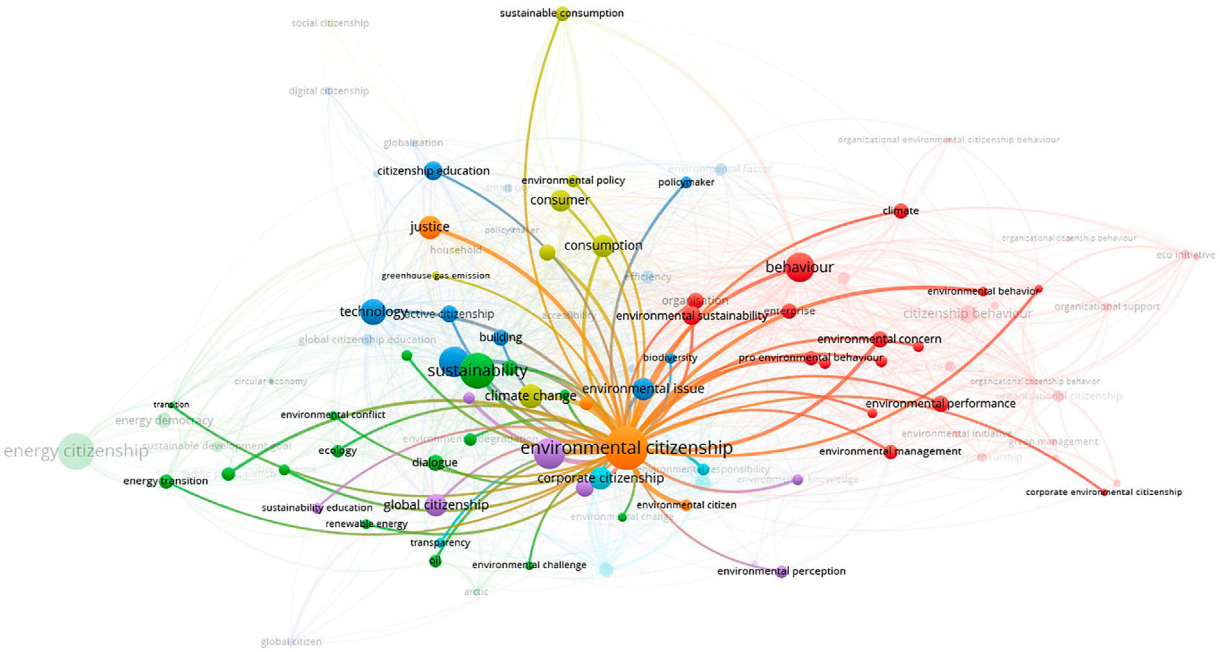

FIGURE 7
Co-occurrence analysis for the term "environmental citizenship".

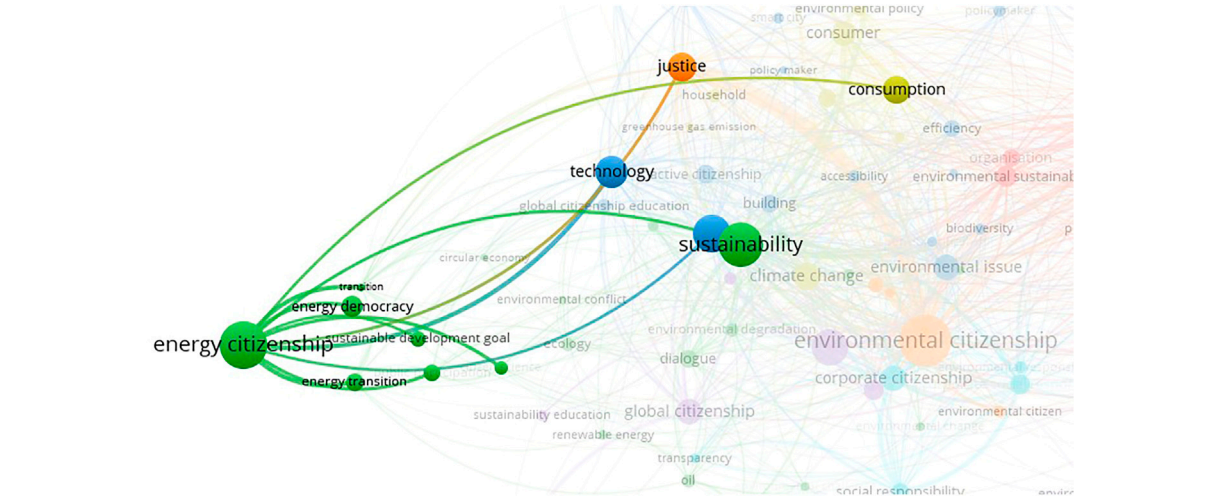

FIGURE 8
Co-occurrence analysis for the term "energy citizenship".

sustainability, behaviour, and environmental citizenship. In a parallel fashion, the term energy citizenship is connected to a small number of different clusters of terms. Accordingly, from different clusters, energy citizenship is connected to the overarching term of sustainability, as well as to the terms of technology, consumption, and justice. At this point, it is worthwhile noting that energy citizenship is not directly connected to environmental citizenship but through the mediating term of justice.

The analysis of the co-occurrence visualization for energy citizenship also shows that the discussion regarding energy citizenship in the literature is merely

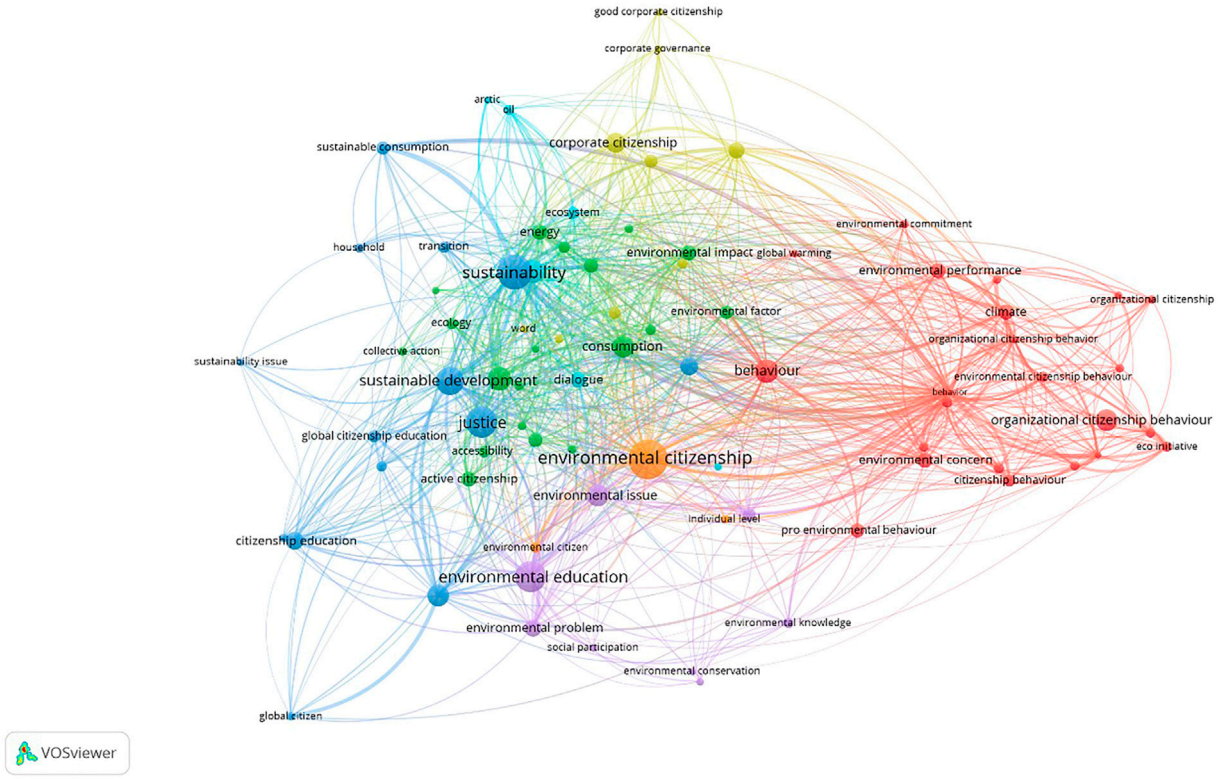

FIGURE 9
Cluster analysis for the search query "environmental citizenship".

constructed around a set of closely-related and frequently oft-cited terms (see Figure 8). Along with the term "energy citizenship", these terms include "energy transition", "energy democracy", and "sustainable development goals". From one perspective, this can be interpreted as the joint development of a set of emerging complementary concepts. From yet another perspective, it might be argued that the analysis of the concept of energy citizenship in the literature has been focused on a very limited set of terms, failing to establish the connection to the themes of the contemporary debate and become a significant item in the research agenda. These different viewpoints may be better evaluated through a chronological analysis of how these terms continue to be elaborated in the literature. This will be discussed in more detail in the following section.

4.3.2 Cluster analysis

The first analysis regarding clusters was conducted in order to single out the analysis for the term "environmental citizenship", excluding the term "environmental citizenship". For this purpose, the search term "environmental citizenship" was used, and the results were filtered to exclude the term "energy citizenship".

The resulting Network Visualisation is presented in Figure 9. Based on the analysis of 83 items, 6 clusters are identified.

The first cluster is associated with the term environmental citizenship. Although this cluster involves a quite limited number of terms, including "environmental citizenship", environmental citizen" and "individual level", it is central and strongly connected to the other clusters.

The second cluster integrates the terms associated with sustainability, energy transition, citizenship, and justice. Hence, this cluster mainly establishes the strong connection between these concepts. Regarding sustainability, the terms "sustainability", "sustainable development", "sustainability issue", and "sustainable consumption" are in this cluster. The term "transition" is connected to "household", reflecting the more operational aspects studied in the literature, as well as "sustainable consumption" and "sustainability" that demonstrate the emphasis on the overall principles. When the terms directly associated with citizenship are concerned, this cluster involves "global citizen" as an emerging term, "global citizenship education", and "citizenship education" as more frequently cited terms. Finally, the high-frequency term "justice" is connected with "sustainable development" and "global citizenship education", demonstrating that the researchers have identified and elaborated on the strong connection between these concepts.

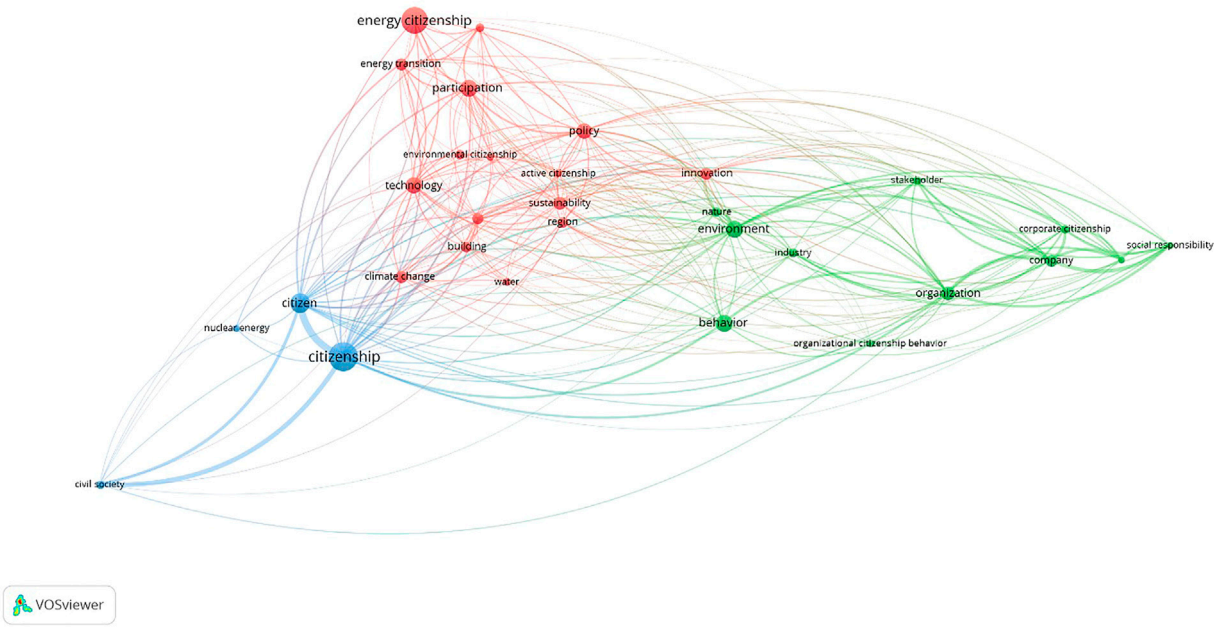

FIGURE 10
Cluster analysis for the search query "energy citizenship".

There are three clusters that have the term "environment" as the common theme. The first of these clusters involves terms that connect environment and energy. Including the terms of "energy", "consumption", "environmental impact", "environmental factor", and "ecology", this cluster is also connected to the first two clusters through the inclusion of the terms and "collective action" and "active citizenship". With the concept of activism related with environmental citizenship being demonstrated in this cluster, the cluster with the highest number of interrelated terms is what can be named as the environmental behaviour cluster. Within this cluster, significant terms defining the challenges such as "global warming", "environmental concern", and "climate", are associated with the counterparts that define the approaches to tackle the challenges, such as, "behaviour", "pro-environmental behaviour", "environmental citizenship behaviour", "citizenship behaviour", "organizational citizenship behaviour", "eco initiative", and "environmental commitment". The high number of terms and the high frequencies of occurrences of these terms demonstrate the emphasis placed on these terms by the studies in the literature. The third cluster with the common theme of environment includes the keywords "environmental issue" and "environmental problem" as the challenges and "environmental education", "environmental knowledge", "environmental conservation", and "social participation" as the types of means to address these challenges.

The last cluster in this analysis takes the corporate approach as central, emphasizing the role of formal constructs in terms of environmental citizenship. This cluster is closely linked to the sustainability, behaviour, and energy clusters. The main terms included in this cluster are "corporate citizenship", "good corporate citizenship", and "corporate governance".

The second analysis provides a similar perspective, this time for "energy citizenship". In this case, a much smaller number, 31 items were identified. The resulting network visualization is shown in Figure 10. This analysis results in three clusters. In this case, the central cluster can be characterized by the term "energy citizenship". Along with "energy citizenship", this cluster involves a number of closely-related terms including "climate change", "sustainability", "energy transition", "environmental citizenship", "active citizenship", "participation", "policy", "technology", "innovation", "building", and "water".

The second cluster in this analysis focuses on the formal structures as stakeholders of energy citizenship. In addition to the integrating terms of "nature", "environment", and behaviour, this cluster includes the terms "stakeholder", "organization", "industry", "corporate citizenship", and "organizational citizenship behaviour", and "social responsibility".

The final cluster, on the other hand, reflects the individual/citizen focus. The terms in this cluster are "citizen", "citizenship", "civil society," and "nuclear energy".

A broader perspective can be obtained when both terms "environmental citizenship" and "energy citizenship" are

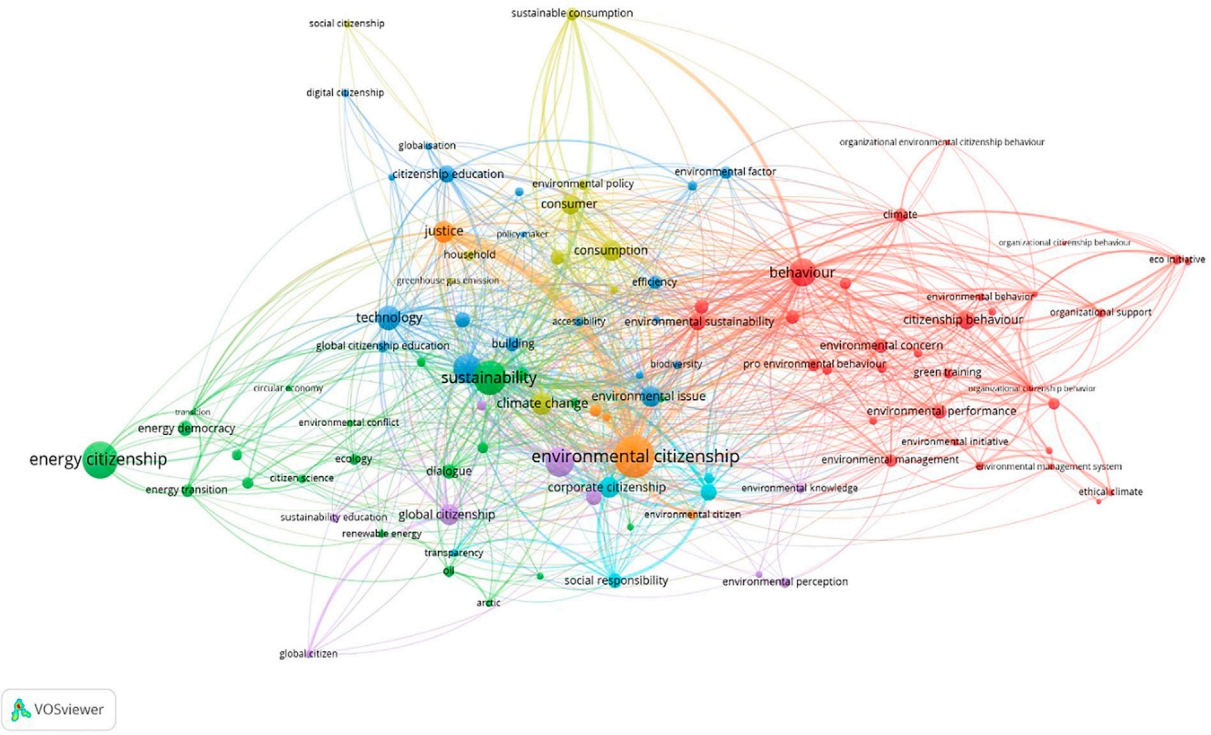

FIGURE 11
Cluster analysis for the search query "environmental citizenship" or "energy citizenship".

included in the analysis. The associated network visualization is provided in Figure 11. As expected, the resulting analysis has a higher number of items (103), with seven clusters. Three clusters from the first analysis (that included environmental citizenship only) also appear here. These are the environmental citizenship, sustainability, and environmental behaviour. In this case, the sustainability cluster is integrated with the energy citizenship cluster of the first analysis (that included environmental citizenship only) and that of the second analysis (that included energy citizenship only). In all cases, the clusters have a wider scope, with a higher number of terms and/or, a stronger connection of terms within the cluster or with the other clusters.

The first cluster is central to the analysis and is characterized by environmental citizenship and includes the main terms of "environmental citizenship", "environmental citizen", and "justice".

The second cluster is the sustainability and environmental citizenship cluster. These two terms also have the highest frequencies of occurrences. The other closely-related terms in this cluster are "energy transition", "renewable energy", the emerging concept of "circular economy", "energy democracy", "citizen science", "ecology", "environmental conflict", and "dialogue". This cluster is closely linked to the sustainability, energy citizenship, and environmental citizenship clusters.

The environmental behaviour cluster that includes the terms of "climate", behaviour", "environmental behaviour", "pro-environmental behaviour", "environmental concern", "environmental performance", "environmental initiative", "organizational citizenship behaviour", "organizational citizenship behaviour", and "eco initiative" is now extended to include the terms "environmental management ", "environmental management system", "organizational support", "ethical climate", and "green training".

Another cluster emphasized the role of emerging and technology-related concepts in terms of environmental citizenship and energy citizenship. The terms included in this cluster are "environmental factor", "efficiency", "technology", "globalisation", "digital citizenship", "citizenship education", and "global citizenship education".

The fifth cluster in this analysis focuses almost solely on the consumer perspective. This cluster includes the terms "climate change", "consumer", "consumption", "sustainable consumption", and "social citizenship".

The sixth cluster connects the terms "global citizen", "global citizenship", with their awareness and information requirements, including "environmental knowledge", "environmental perception", and "sustainability education".

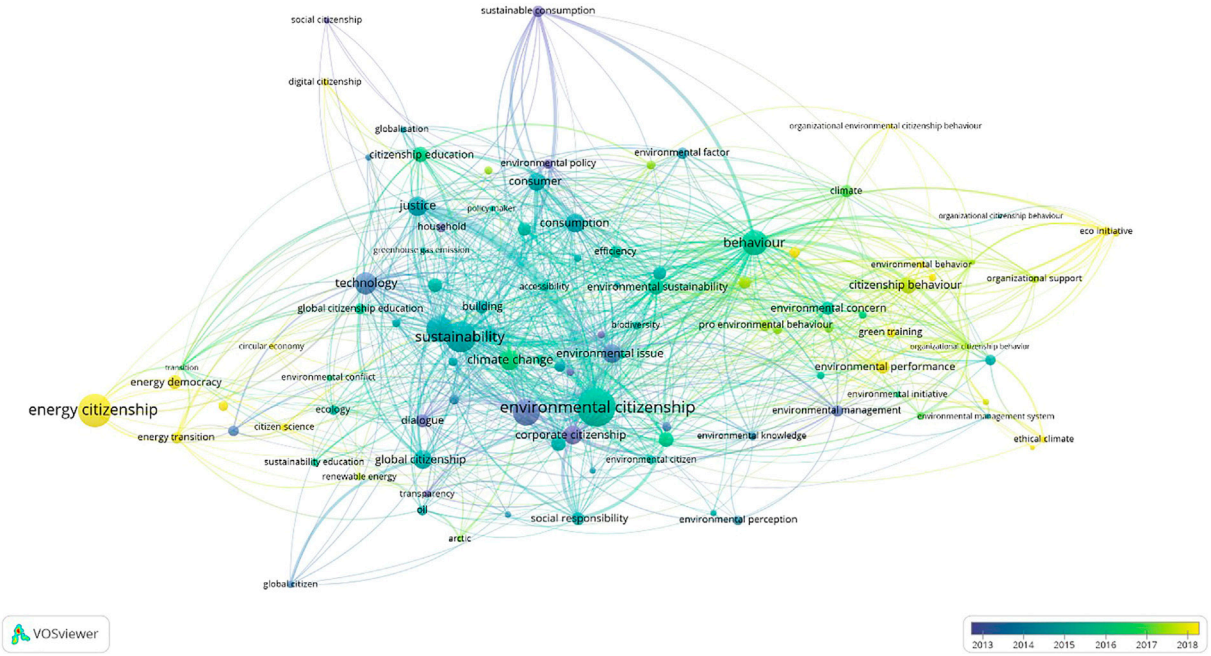

FIGURE 12
Cluster density visualization for the search query "environmental citizenship" or "energy citizenship.

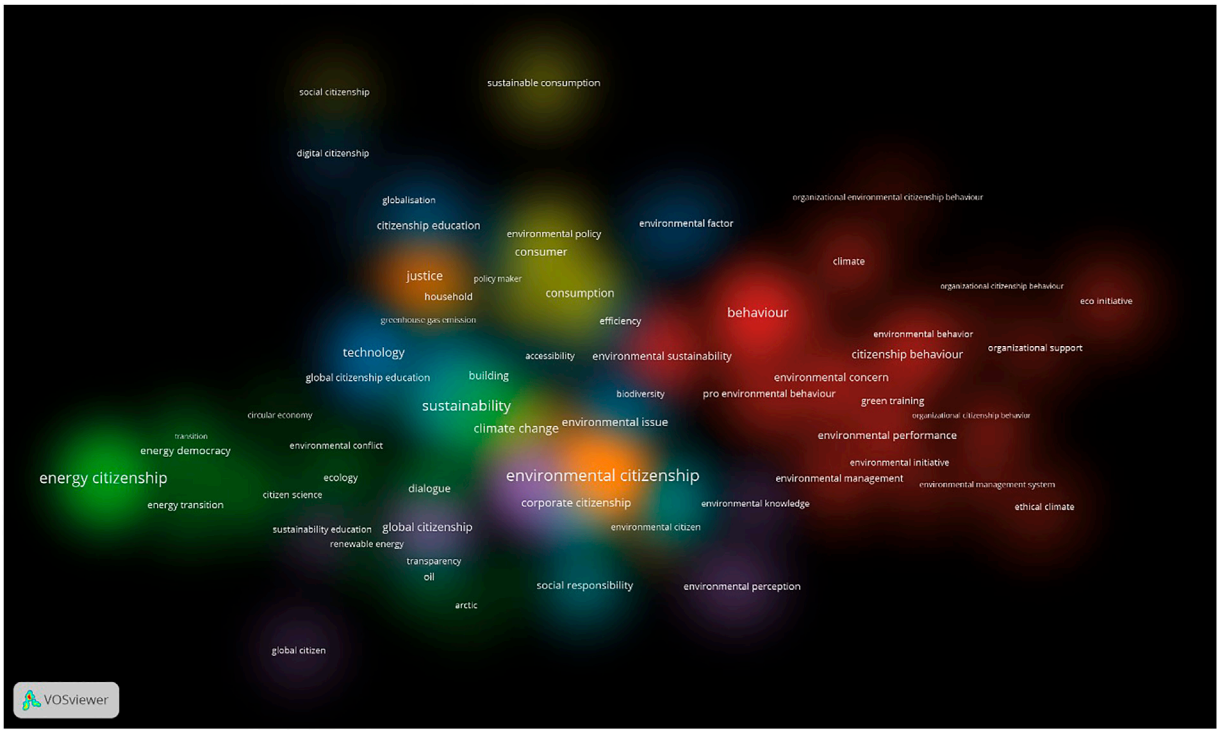

FIGURE 13
Item density visualization for the search query "environmental citizenship" or "energy citizenship".

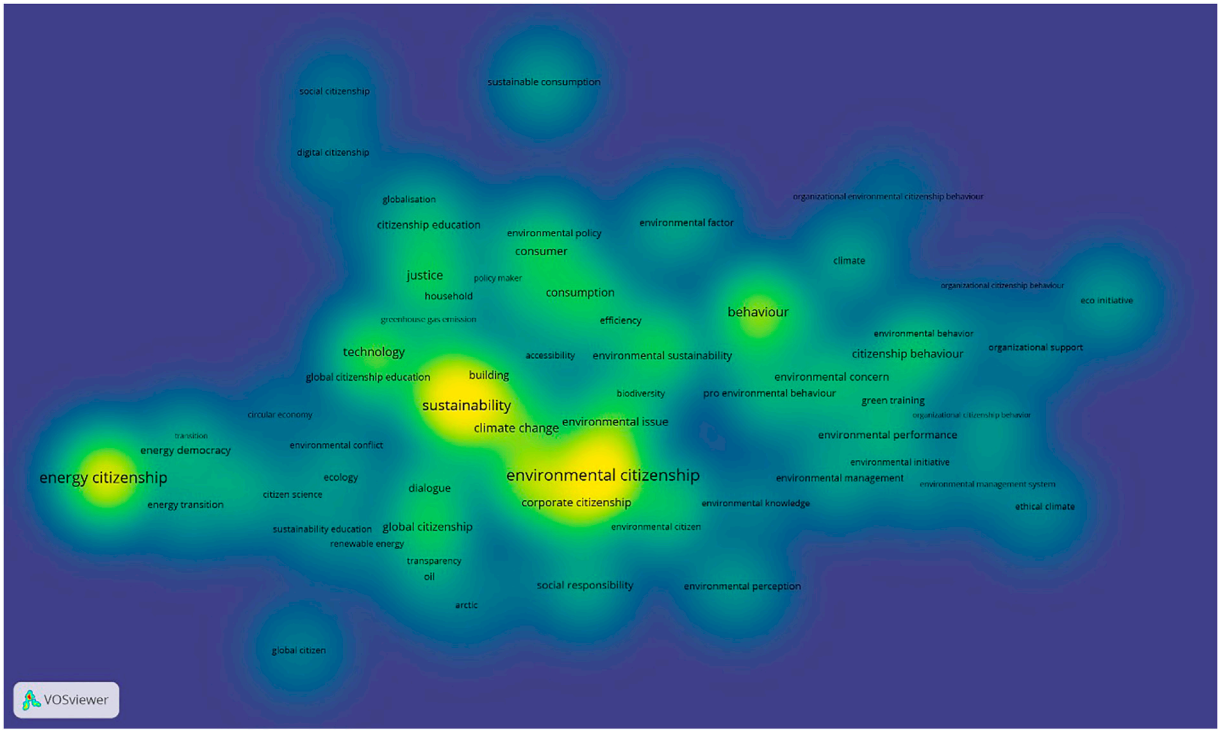

FIGURE 14
Overlay visualization for the search query "environmental citizenship" or "energy citizenship".

In line with both the first and second analysis, the seventh cluster in this analysis also focuses on the corporate aspects. The main terms in this cluster are "corporate citizenship" and "social responsibility".

The cluster density visualization provides an overview of the link strengths of the aforementioned clusters and their relationships with the other clusters. The cluster density visualization depicted in Figure 12 highlights the central position of the environmental citizenship cluster. The main focus of the discussions regarding this cluster is environmental citizenship and justice. The environmental citizenship cluster and the cluster referring to the role of formal constructs in environmental citizenship and energy citizenship act as transition clusters, linking the more contemporary debates on energy citizenship and environmental behaviour. One other observation that can be drawn from the cluster density visualization is the concentration on the environmental behaviour cluster and the energy citizenship cluster. That is, these two terms, with the related terms around them, are likely to dominate the scholarly debates concerning environmental citizenship and energy citizenship.

The item density visualization provided in Figure 13 below provides an additional perspective of the central and transition themes, based on individual terms rather than based on clusters. In line with the preceding analysis, the terms, terms environmental citizenship, behaviour, biodiversity, sustainability, consumer, consumption, environmental policy, technology, efficiency, and building are identified as the common grounds of the scholarly research on environmental citizenship and energy citizenship, with the terms sustainability, environmental citizenship, behaviour, and energy citizenship having the highest frequencies of occurrence.

Utilizing the same setup, including both terms, environmental citizenship, and energy citizenship, a chronological perspective is provided by the overlay visualization of the VOSviewer software. Along with the occurrence frequencies of terms and the links between these terms, the overlay visualization also provides a perspective of the timelines over which the terms appear as oft-cited terms in the literature. The overlay visualization is depicted in Figure 14.

The first observation that can be drawn from the overlay is visualization considering the time interval from 2009 to 2022 is that the term "environmental citizenship" marks the beginning of the timeline, as one of the earliest terms being debated, whereas the term "energy citizenship" marks the most recent points in the timeline, suggesting a shift from the more conventional concept of environmental citizenship to the more contemporary discussion of energy citizenship.

Recalling that the co-occurrence analysis for the term energy citizenship that is obtained by constructing a sub-network

including the term and its immediate links only, resulted in a condensed sub-network with a small number of related terms, the preceding discussion supports the idea that a set of emerging complementary concepts around the term "energy citizenship" is joint developing and becoming the focus of research concerning environmental citizenship and energy citizenship.

Through a closer look, the overlay visualization highlights "environmental citizenship", "corporate citizenship", "sustainable consumption", "environmental policy", "technology", and "dialogue" as the initial terms of focus. Later, the debate in the literature evolves to discuss "climate", "climate change", "environmental concerns" as the diagnosis, "consumer", "consumption", and "behaviour" as the focal topics for the challenge and "efficiency", "renewable energy", "environmental citizen", and "citizenship education" as the pathways for the resolution. Finally, the more contemporary terms of "energy citizenship", "energy transition", "energy democracy", "pro-environmental behaviour", "eco initiative", "environmental performance", "green training", and "citizen science" are being debated more frequently in the literature.

5 Conclusion

The concepts of environmental citizenship and energy citizenship are critical for climate change mitigation and the energy transition. With a non-territorial and activism-based perspective regarding both concepts, an analysis of the scholarly debates around these terms reveals how these terms are discussed in the literature, what other terms are discussed alongside these terms and how these discussions evolve chronologically to highlight emerging themes. The analysis also identifies how the concepts of environmental citizenship and energy citizenship are perceived and positioned, as relative to one another and to other terms. These results have significant implications in terms of understanding whether the relationships between the related phenomena are established as foreseen, contributing to the theoretical development and operationalization processes of environmental citizenship and energy citizenship, in the path towards the energy transition and climate change mitigation.

When the occurrences and co-occurrences of individual terms are analysed, the overarching terms of sustainability and behaviour appear as the most-frequently cited terms, and as the terms with the highest number of associations with other terms in the literature concerning the research on environmental citizenship and energy citizenship. Hence, without much surprise, the studies in the literature establish strong links between sustainability, behaviour, environmental citizenship, and energy citizenship. This result establishes the relationship of the environmental citizenship and energy citizenship concepts with the overall and global principle of sustainability and also conforms to the defining characteristics of environmental citizenship and energy citizenship as being global and non-territorial. On the other hand, the emphasis on behaviour shows that environmental citizenship is conceptualized and discussed primarily through its second essential aspect, that is, activism. Hence, the research characterizes environmental citizenship through behaviour rather than a state of mind or attitude. A similar conclusion holds for energy citizenship. This implies that among the pathways to energy citizenship, those that relate to behaviour (such as the adoption of energy savings behaviour, behaviour change for energy conservation, and low-carbon behaviour) are the foremost topics analysed in the literature.

The bibliometric analysis provides further insights when the relationships between classes or sets of terms are investigated. Such analysis identifies terms that are closely-related to one another, forming clusters of terminology, as well as how these clusters are connected to one another. For instance, the co-occurrence analysis provides an isolated perspective of a single terms (or a collection of terms) and how they are connected to the other terms. The co-occurrence analysis is conducted for the four main terms (sustainability, behaviour, environmental citizenship, and energy citizenship) identified by the bibliometric analysis. The analysis for the terms sustainability and behaviour once more emphasizes the significance of these terms, reflected by their connections to a comprehensive set of other terms from different clusters. Besides, the co-occurrence analysis for the terms sustainability, behaviour, and environmental citizenship all place environmental citizenship in a central position concerning the debates in the literature. However, the situation is different when the term energy citizenship is considered. The corresponding co-occurrence analysis still establishes a strong relationship with the overarching terms of sustainability and behaviour. However, the term is not directly connected to environmental citizenship but rather through the term justice. The analysis for energy citizenship also deviates from those of the preceding main terms in the sense that the term is merely associated with a limited set of terms that are closely connected to one another, including "energy transition", "energy democracy", and "sustainable development goals". Later, through the analysis of the chronological evolution of terms, this is identified as the evidence of a shift of focus to the concept of energy citizenship along with a set of emerging complementary concepts. That is, when the related literature within the time interval between 2009 and 2022 is analysed, in the initial years, the term "environmental citizenship" appears among the most-cited terms. However, moving towards 2022, the trajectory of the discussions changes to be more oriented towards the concept of energy citizenship. Hence, this suggests a shift from the more conventional concept of environmental citizenship to the more contemporary discussion of energy citizenship and a set of closely-related complementary emerging concepts around the term "energy citizenship" becoming the focus of research concerning environmental citizenship and energy citizenship. However, this does not refer to a definitive deviation from environmental citizenship, nor mean that the concept of environmental citizenship is replaced by the concept of energy

citizenship. It rather points to a now more focused debate in the literature regarding energy citizenship, where, as also evidenced by the preceding discussion, the concept of environmental citizenship still keeps its central position, but possibly increasingly more as an overall principle, like in the cases of sustainability and behaviour. As evidenced by the bibliometric analysis, the term environmental citizenship also acts as a transition term, establishing the connection between the earlier debates with the more recent debates in the timeline. Clearly, the shift in the oft-cited terms does not only cover energy citizenship. It also involves more contemporary terms of "energy transition", "energy democracy", "eco initiative", "environmental performance", "green training", and "citizen science".

The cluster analysis provides results that support the earlier findings. One cluster of interrelated terms is characterized by environmental citizenship, with strong connections to other clusters. Another cluster is identified by the concepts of sustainability, energy transition, citizenship, and justice. Three clusters are marked with the environment as the common theme. These correspond to energy and environment, behaviour and environment, and society and environment, respectively. The last cluster is somewhat different from the earlier ones in terms of scope and related terms. This cluster points out the emerging theme of corporate approach concerning environmental citizenship and energy citizenship, emphasizing the role of formal constructs in terms of environmental citizenship, including the terms of "corporate citizenship", "good corporate citizenship", and "corporate governance".

Data availability statement

Data concerning this article is available upon reasonable request from the corresponding author.

Author contributions

Conceptualization, MB and MD; methodology, MB; formal analysis, MB, MD, BS, and UT; investigation, MB, MD, BS, UT; resources, MB; data curation, MB, MD, BS, UT; writing—original draft preparation, MB, MD, BS, and UT; visualization, BS and UT; supervision, MB; project administration MB; funding acquisition, MB. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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